

The
AMSAT[®]
Journal

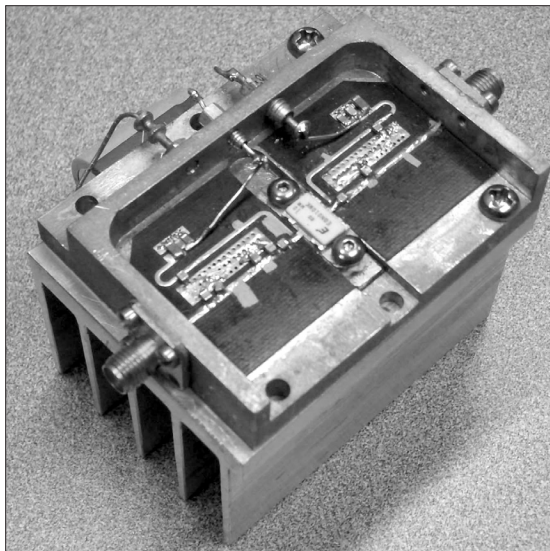


Volume 29, Number 4

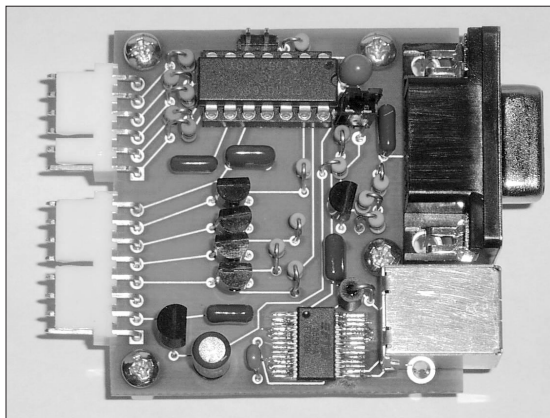
July/August 2006

Editor-in-Chief:
Ed Long, WA4SWJ

Editorial Staff:
Bill Hook, W3QBC
Lee Herterich, K1VZI



New S-Band Amplifier Technology



Simple Satellite Tracker Reprise

AMSAT-NA
850 Sligo Avenue, Suite 600
Silver Spring, MD 20910-4730

Periodicals

POSTAGE PAID

At Silver Spring, MD
and at additional
mailing offices

in this issue

AMSAT Announcements	2
Apogee View	3
<i>by Rick Hamby • W2GPS</i>	
Simple Satellite Tracker for	4
<i>Yaesu G5500 or G5600 Rotors</i>	
<i>by Mark Spencer • WA8SME</i>	
My Helical Feeds and Antennas	5
Project	
<i>by Robert V. Johnson • W7LRD</i>	
Board of Directors Election	6
Statements	
A 2.4 GHz Test Generator	8
<i>by Diane Bruce • VA3DB</i>	
Engineering Notebook II	9
<i>by Bob McGwire • N4HY</i>	
Simple Satellite Tracker	13
Schematic	
<i>by Mark Spencer • WA8SME</i>	
A High Efficiency S-Band	14
Power Amplifier	
<i>by Marc Franco • N2UO</i>	
A 2.4 GHz Helix for	16
Portable Use	
<i>by Diane Bruce • VA3DB</i>	
AMSAT Field Day Report	18
<i>by Bruce Paige • KK5DO</i>	
The Orbital Classroom	20
"1000cc Science"	
<i>by Dr. H. Paul Shuch • N6TX</i>	
Using the AO-51 Digipeater	21
<i>by Bob Bruninga • WB4APR</i>	
Cliff Buttschardt - SK	22
<i>by Emily Clarke • N1DID</i>	
AMSAT Eagle Update	24
<i>by Jim Sanford • WB4GCS</i>	
Recipe for a Field Day Failure	26
-- and How to Recover	
<i>by Jim Sanford • WB4GCS</i>	
National Fund Raising	27
Project Status Report	
<i>by Gunther Meisse • W8GSM</i>	
High Performance Software	28
Defined Radio	
<i>by Bob McGwire • N4HY</i>	
Build this Cheap and Easy	30
Satellite Downlink Antenna	
<i>by Richard F. Crow • N2SPI</i>	



How You Can Help Build New and Exciting Satellites

Donate to the President's Club

Gold, Silver, Bronze and Core levels are available to match your ability to participate.

Cash Gifts

Visa, or MasterCard or checks are accepted. And, you can specify how your contribution is to be used.

Gift of Life Insurance

US taxpayers may be able to receive a significant income tax deduction by making The Radio Amateur Satellite Corporation the owner and beneficiary of life insurance policies.

Gift of Stocks or other Securities

US taxpayers should be able to avoid capital gains taxes on appreciated securities and receive a deduction for their fair market value.

Bequest

A codicil in your will, naming The Radio Amateur Satellite Corporation as a beneficiary will help insure the continuance of the Amateur Radio Satellite program.

Call the AMSAT-NA office at 301-589-6062 for questions on any or all of these ways you can help build new and exciting satellites.

Support AMSAT-NA

AMSAT Announcements

The AMSAT Board of Directors election is in progress! Please return your ballots marked with your votes so they are in the AMSAT office no later than September 15, 2006.

AMSAT's Mission

AMSAT is a non-profit volunteer organization which designs, builds and operates experimental satellites and promotes space education. We work in partnership with government, industry, educational institutions and fellow Amateur Radio societies. We encourage technical and scientific innovation, and promote the training and development of skilled satellite and ground system designers and operators.

AMSAT's Vision

Our Vision is to deploy high earth orbit satellite systems that offer daily coverage by 2009 and continuous coverage by 2012. AMSAT will continue active participation in human space missions and support a stream of LEO satellites developed in cooperation with the educational community and other amateur satellite groups.





Radio Amateur Satellite Corporation (AMSAT-NA)
 850 Sligo Ave., Silver Spring, MD 20910-4703
 Telephone: 301-589-6062 – Toll Free: 888-322-6728
 Facsimile: 301-608-3410
 AMSAT-NA Club Callsign: W3ZM
 AMSAT-NA Web site: <http://www.amsat.org>

The AMSAT Journal Staff

Editor-in-Chief: Ed Long, WA4SWJ
 (wa4swj@amsat.org)

Circulation: Martha Saragovitz
 (martha@amsat.org)

Editorial Staff:
 Bill Hook, W3QBC
 Lee Herterich, K1VZI

AMSAT-NA Board of Directors

Barry Baines, WD4ASW; Tom Clark, K3IO
 Emily Clarke, N1DID; Rick Hambly, W2GPS
 Lou McFadin, W5DID; Gunther Meisse, W8GSM
 Paul Shuch, N6TX; First Alternate: Bob McGwier, N4HY
 Second Alternate: Lee McLamb, KU4OS

AMSAT-NA Officers

President:

Rick Hambly, W2GPS

Executive Vice-President:

Lee McLamb, KU4OS

Vice-President, Operations:

Mike Kingery, KE4AZN

Vice-President, Engineering:

Bob McGwier, N4HY

Vice President, Marketing and User Services:

Barry Baines, WD4ASW

Vice-President, Human Space Flight:

Frank Bauer, KA3HDO

Treasurer:

Gunther Meisse, W8GSM

Secretary:

Stephen Diggs, W4EPI

Manager:

Martha Saragovitz

Honorary Positions

Immediate Past President:

Robin Haighton, VE3FRH

Past President Emeritus:

Tom Clark, K3IO

Founding President:

Perry Klein, W3PK

Editorial Office: Ed Long, WA4SWJ, 6685 SE 108th Street, Belleview, FL, 34420-3449, e-mail Journal submissions to: journal@amsat.org, telephone: 262-374-1349. **Advertising Office:** AMSAT-NA Headquarters, 850 Sligo Avenue, Suite 600, Silver Spring, MD 20910-4703.

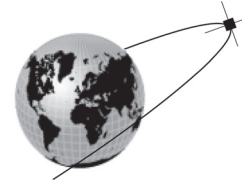
The AMSAT Journal (ISSN: 1407-3076) is published bi-monthly (Jan/Feb, Mar/Apr, May/Jun, Jul/Aug, Sep/Oct, Nov/Dec) by AMSAT-NA, 850 Sligo Avenue, Suite 600, Silver Spring, MD 20910-4703. Telephone: 301-589-6062, fax: 301-608-3410. Periodicals postage paid at Silver Spring, MD and additional mailing offices. **Postmaster:** Send address changes to *The AMSAT Journal*, 850 Sligo Avenue, Suite 600, Silver Spring, MD 20910-4703.

Opinions expressed in *The AMSAT Journal* are those of the article authors and are not necessarily those of AMSAT-NA. Copyright © 2006 by AMSAT-NA, The Radio Amateur Satellite Corporation. AMSAT is a registered trademark. Reproduction of material from *The AMSAT Journal* by mechanical, electronic, photocopy or other means is prohibited unless written permission is obtained from the author.

The AMSAT Journal staff is always interested in article submissions. Whenever possible, submissions should be sent via e-mail to journal@amsat.org using plain text or word processor files; photos or figures in TIF, GIF or JPEG formats. AMSAT-NA reserves the right to select material for *The AMSAT Journal* based on suitability of content and space considerations. The editors of this publication are volunteers giving freely of their talents, time and efforts to produce *The AMSAT Journal*.

APOGEE VIEW

by Rick Hambly, W2GPS • w2gps@amsat.org



Eagle Digital Design Meeting

An important Eagle design meeting was held in San Diego on June 29-30th. This meeting reviewed Eagle's goals, established a new set of user-based requirements and used scientific analysis to determine the extent to which we could practicably achieve the goals and requirements.

The goals are to: 1) bring HEO satellite communications capability to those who cannot use satellites today; 2) provide effective communications at frequencies that allow manageable antenna sizes and power levels; and 3) minimize the need for complex and expensive antenna steering and frequency tracking mechanisms. We need solutions that make sense. To underpin the solution set with a robust digital data link is an obvious and appropriate first step. These goals set the tone for the design but are not requirements.

Requirements were evaluated using this new user-based perspective. "Class 0" is a traditional linear transponder user. "Class 1" is a low data rate text messaging user with a hand-held or mobile ground station. "Class 2A" is a digital voice user with a coarsely steered antenna or an electronically aimed patch array. "Class 2B" is a digital voice user with a steerable 60cm dish. "Class 3" is a digital video user with a 1.8m or larger steerable dish.

The meeting conclusions were as follows.

1. The originally proposed Eagle structure will not support the mission requirements. We have a new structure proposal that is very similar to the original except that it has six sides, giving us more power and more room for antennas.
2. We will have a mode S/C digital transponder in place of the proposed mode C/C transponder ("C-C Rider"). It will be capable of supporting 20 conference grade digital voice channels and other services with a 60 cm dish and a dual band feed. It will alternatively support two streaming video channels with a 1.8-meter dish on the ground.
3. We will have a mode U/V transponder based on Software Defined Transponder (SDX) and digital HELAPS technology. In addition to traditional linear modes, this transponder will provide SMS-like text messaging with no antenna pointing necessary. This mode will support mobile and portable operation. A preliminary

prototype of this transponder was shown by AMSAT at Dayton and was the "sweetest sounding transponder ever heard" according to VP Engineering Bob McGwier, N4HY, and it wasn't "killed by alligators".

You can find more information on Eagle on the new EaglePedia section of the AMSAT Web site.

Coming Attractions

Over the next few weeks AMSAT will be represented at the 40th Anniversary Central States VHF Society Conference, the 2006 ARRL Maryland State Convention, the ARRL Board of Directors meeting, the 2006 SmallSat Conference, the 25th Annual ARRL and TAPR Digital Communications Conference, and the AMSAT-UK Colloquium 2006. AMSAT presentations will be made at each of these.

This kind of commitment by your AMSAT leadership in the middle of what should be their vacation period shows a high level of commitment and dedication to AMSAT, its goals and its membership. The next time you see one of these officials tell them that you appreciate their dedication.

A New Alliance

AMSAT is faced with a rare opportunity that I feel we must take advantage of now. There are a few times in the course of events where you can easily join a major technological development and have a positive impact on both that development and on your own primary interests. The High Performance Software Defined Radio (HPSDR) project is one of those developments. To learn more, see: <http://hpsdr.org/>

It is the intention of AMSAT's President and V.P. Engineering to support HPSDR with a modest amount of resources, including money, personnel and access to some of AMSAT's development tool licenses.

The goal for AMSAT is to dramatically improve both the development schedule and the quality of our Eagle ground station and spacecraft SDX and wideband digital transponders.

I expect you will be hearing more about this alliance from our VP Engineering and our Eagle design team in the coming weeks and months, as this initiative takes shape.

continued on page 4 ...



Apogee View continued from page 3.

2006 Space Symposium

Do you want to learn more about AMSAT's projects and inner workings? Do you want to meet people you have only read about or with whom you have only exchanged e-mails? Now is the time to plan for the AMSAT 2006 Space Symposium and Annual Meeting to be held in October 2006 near San Francisco.

For more information see the AMSAT Web site at www.amsat.org and click on the 2006 Space Symposium icon on the left column or call Martha at the AMSAT office (301) 589-6062.

AMSAT Needs You!

AMSAT needs your support to achieve our goals. Our Eagle Build Campaign for 2006 has now raised over \$100,000 toward our goal of \$150,000. Please call the office or visit the AMSAT Web store to make your donation for 2006. Remember, all donations of \$120.00 or more qualify for President's Club status. Your generous contribution to AMSAT is what keeps projects like Eagle and P3E moving forward.

We need more volunteers to set up or work in the AMSAT booth at hamfests and to give presentations at local ham clubs. For more information contact the AMSAT office or any of your AMSAT officers by using the Web site's message forms (click on "About AMSAT" then "Our Leadership Team" then click on any name).

73,

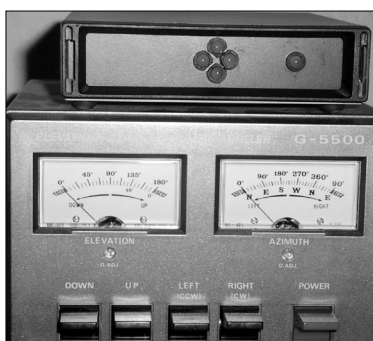
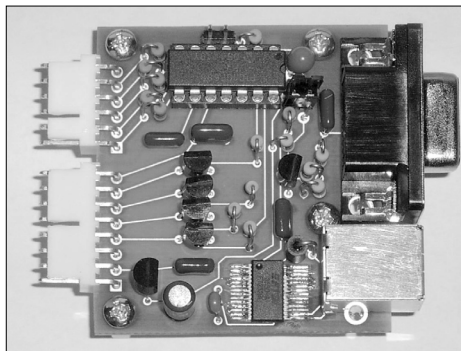
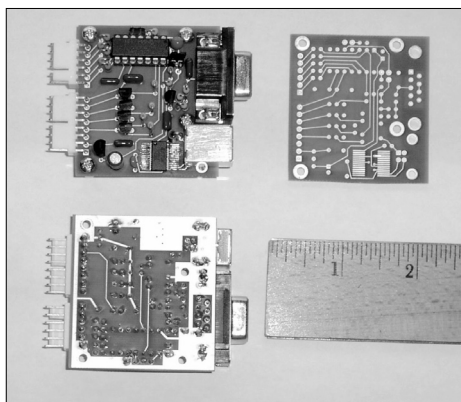
Richard M. Hambly, W2GPS

AMSAT President

AMSAT Telemetry

Simple Satellite Tracker

In the last issue of *The AMSAT Journal* Mark Spencer, WA8SME, published an article about a simple rotor control to track satellites. Mark has created some printed circuit boards for the project. Please contact Mark at m Spencer@arrl.org for more information. Pictures of the board are below including one of the board mounted in an enclosure. Mark has also made some firmware changes to the project.



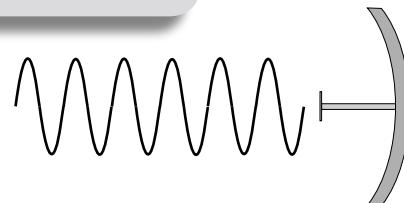
THE R.F. CONNECTION

"Specialist in
R.F. Connectors and Coax"
<http://www.therfc.com>

301/840-5477
Fax 301/869-3680
E mail: rfc@therfc.com

Order Line 800/783-2666
Suite 11, 213 N. Frederick Ave.
Gaithersburg, MD 20877

See page
13 for
updated
schematic.



amsat.org

The AMSAT "Store" is open !

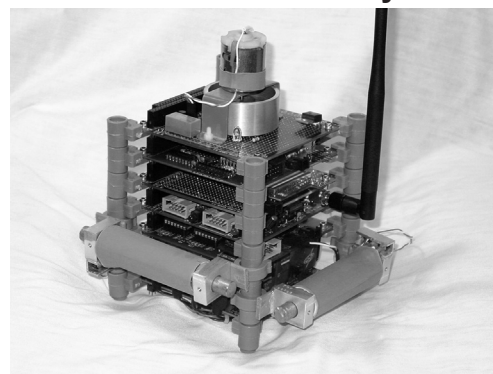
It's a Great place to Holiday shop.

- Books
- Software
- Apparel
- Memberships
- Trinkets
- Stickers
- Awards

Check it out at www.amsat.org
tab "store"

Try it, you'll love it !

EyasSAT™ Educational Satellite System



**Satellite engineering education tool.
In use at Universities and NASA.
EPS/ADCS/Data/Comm/Structure +
ground station +
easy add-on modules.**

Visit www.eyassat.com or call
(303) 840-1907



My Helical Feeds and Antennas Project

Robert V. Johnson, W7LRD, w7lrd@amsat.org

It all started quite innocently enough. AO-40 was up and after the "incident" we at least had a 2.4 GHz downlink. First I had to learn what a GHz was; that's a lot of Hz's put together. I got a Primestar dish free for the asking and was given a 5-1/2-turn helix to hang in front of it. After acquiring a 3731AA downconverter from K5GNA, I was now on AO-40! This was the greatest thing since sliced bread! After a while I built a better helix and then noticed several Primestar dishes in the neighborhood staring aimlessly skyward. Having that entrepreneurial spirit I acquired several of those dishes and built several feeds and started peddling them to support new and better things for the ham shack. See *The AMSAT Journal*, March/April 2004, page 29.

After a while my efforts were slowed as the supply of unused dishes was quickly being used up. I then realized other hams could also look around their neighborhoods and probably find a few dishes to use. I thought they would probably like a nice quality, reasonably priced feed for their own AO-40 antennas. I thought I could make a simple and inexpensive helical feed that I could sell inexpensively that others could use.

While trying to come up with a cost-effective solution I went through the anguish to trying various construction methods that didn't take all day to make. I started with trying to put threads on a plastic rod to hold the rod to the reflector to hold the helix in place. This worked but was very fragile. (If any of you have one of these of my first efforts and it broke, I will replace it for free with the new

and improved version. It is guaranteed it not to rip, rust, bust or break in any way. There might be about a dozen of you out there.) I tried different types of rods, plastic, nylon, acetyl, etc., etc. I settled on using the correct length rod made from either nylon or acetyl, then grinding one end to a point. I then attached it with epoxy into a 3/8 inch brass lamp fitting that I cut to about an inch long. Then, using the lamp fitting nuts I can fasten it to the reflector after I drill six holes at the correct angle to thread the helix on the rod.

I have made jigs and templates to wind the coil, drill the rod and drill the reflector for the 'N' connector as well as mounting holes for the rod. It sounds like a lot of work to get to this stage (just ask Mrs. LRD), and it was, but I have come up with an extremely efficient method of making and reproducing these little guys. I am fortunate that I live about five miles from the Boeing Airplane Surplus Yard. This place is an antenna makers dream store. Aluminum sheet, plate, tubing, titanium on and on are all available there. If you had the time and space you could almost build a 747 in your back yard using materials that can be found there. I have acquired about 90 feet of 316 stainless 'U' channel and it makes a great center support for a longer helix. I use 32 short pieces of nylon drilled and with 32 holes drilled in the stainless steel support and two holes in each of the 32 pieces of rod I have created an almost indestructible helix antenna for 2.4 GHz.

It currently takes many hours to correctly craft one of these beauties. I have used

the same technique on an L-band antenna and am planning a WX satellite antenna. I have made the reflectors from excess airplane aluminum for all these antennas. During this whole process I acquired the book "Antennas" by John Kraus, W8JK (SK). Using that book and others as well as picking the brains of many of you gentlemen, particularly Joe, K0VTY, I have become reasonably conversant with helix antennas. The Web sites of K5OE and W0LMD have proved invaluable. I use eBay as the mode of transaction and it has worked quite well for me. I owe much to AMSAT and the bulletin board. For every question I have ever asked I have always received the right answer. For every helix feed or 16-turn helix antenna that is sold I donate five or ten dollars respectively to AMSAT. AMSAT is getting a few bucks, Bob is upgrading his ham gear and Mrs. LRD gets taken to dinner now and then from the profits to keep the peace. ☺



Photo 2: W7LRD using his helical antennas to work the satellites.



Photo 1: An example of the new helical design.

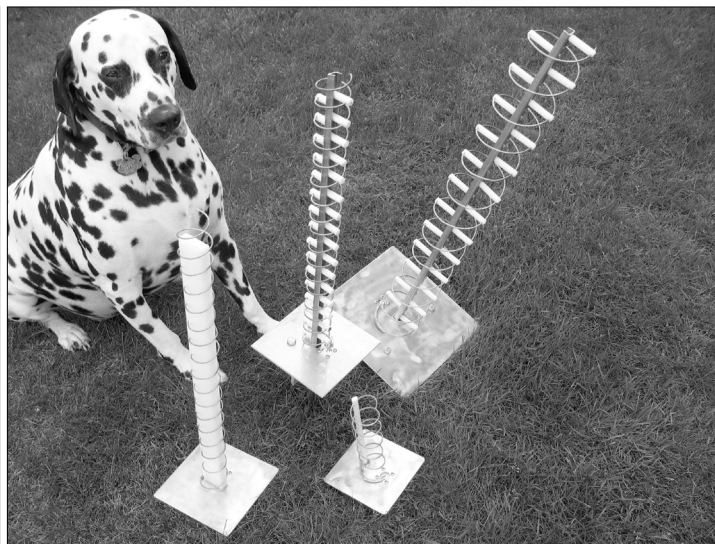


Photo 3: Mac guarding a helical antenna farm.



BoD Election

The AMSAT Board of Directors election is in progress. Ballots were mailed in July to all members and they must be received at the AMSAT office by close of business **September 15, 2006**. Please vote in this election. Return your ballots as soon as possible but they must be in the AMSAT office no later than the date above. Below, in alphabetical order by last names, are statements from each of the candidates for election.

Tom Clark, K3IO

Tom Clark, K3IO, is perhaps better known to AMSAT by his earlier calls, W3IWI and WA3LND. He holds an Extra Class license, and is a Life Member of AMSAT, ARRL and CSVHFS, and lives in Clarksville, MD with his wife, Elizabeth.

Tom has served AMSAT for more than 30 years in a number of roles. He has served on AMSAT's Board since 1974. He was Executive VP from 1975-80 and then took over from W3PK as AMSAT President in 1980. As President, he kept AMSAT alive after Phase-3A was lost in a failure of the Ariane launch vehicle, culminating in the successful flight of AO-10. After stepping down as President, he was honored to being designated President Emeritus. He is now the Board's self-proclaimed curmudgeon and assists W8GSM in developing Eagle's Fund Raising program.

Tom has strived to preserve AMSAT's reputation, technical integrity and leadership in the small satellite world; this has often involved dragging the organization into new technical endeavors. He built the 10M antennas for AO-8. In 1979, when only a few amateurs owned computers, he published the first "open source" elliptical orbit tracking software. Along with NK6K and KD2S, the concept of all-digital amateur satellites was hatched, culminating in AMSAT's Microsats. He developed the uplink receivers and the spacecraft LAN architecture used on all the Microsats (Oscars 16, 17, 18, 19, 26, 27 and 31). He developed the SAREX Packet "ROBOT" originally flown by WA4SIR. Along with N4HY, he developed the first amateur DSP hardware, including a number of modems. Most recently, he has been heavily involved in developing the C-C Rider and Software Defined Transponder concepts for Eagle.

Tom has had many other exploits in Amateur Radio. He has been active in TAPR since its inception; recently this included the development of the "Totally Accurate Clock" and a new high-accuracy GPS-disciplined time/frequency standard. He has been an active VHF/UHF amateur since the 1960's; one notable achievement was earning a 70 cm WAC in less than 12 hours. The Central States VHF Society honored him with their Chambers Memorial Award in 1996. He was inducted into the initial class of CQ Magazine's Amateur Radio Hall of Fame in 2001. On the satellite front, he has earned both WAS (#97) and a rare WAC (#3) using only LEO satellites. Thanks to incessant prodding by N4HY and W2GPS to get back on the air, he is currently awaiting delivery of antennas to replace those lost in an ice storm a few years ago.

Professionally, Tom retired as a senior scientist at NASA's Goddard Space Flight Center in 2001. His research in Astronomy and Geodesy led to the development of Very Long Baseline Interferometry (VLBI) to measure tectonic plate motions (now known to ~10 μ meters/year) and to study variations in the rotation of the earth (to levels of ~5 μ sec/day); these activities led to his election as a Fellow of the American Geophysical Union and the International Association of Geodesy. NASA honored him with the NASA Medal for Outstanding Engineering Achievement and Goddard's Moe Schneebaum Memorial Award. In 2005, he was the first non-Russian to be awarded a Gold Medal by the Russian Academy of Sciences for his VLBI developments. He has authored or co-authored more than 100 scientific papers and monographs. He now serves on several advisory committees and earns spending money as a consultant on topics including VLBI, GPS, Precision Frequency Control and Timing.

Lou McFadin, W5DID

Lou McFadin, W5DID, has been a licensed Amateur Radio operator since 1959. Lou earned his BS degree in Electrical Engineering from Oklahoma State University in 1963. Following graduation he began his career at Texas Instruments in Dallas. While there he was called to active duty and served in the U.S. Navy from 1964 to 1967. After graduating from Officer Candidate School, Lou served onboard the USS Lake Champlain. As a crewmember aboard the Gemini 5 recovery ship Lake Champlain he decided that he wanted to become part of the space program. After his duty for the NAVY he worked for NASA at the Johnson Space Center from 1967 until his retirement in 1995.

Lou's career at NASA involved many technical disciplines and spanned across three decades. Among his most memorable projects were the Apollo Far Ultraviolet Spectrometer Experiment, The Apollo-Soyuz Ultraviolet Absorption Experiment and the Shuttle Amateur Radio Experiment (SAREX).

Lou was one of the hams responsible for making Amateur Radio possible on the ground-breaking STS-9 mission when Dr. Owen Garriott, W5LFL, operated the first ham radio from space on the Space Shuttle Columbia. From 1983 until 1995 Lou was SAREX's principal investigator. During Lou's tenure with SAREX sixteen highly successful Amateur Radio flights were flown.

SAREX quickly grew from a simple experiment just for ham radio operators to a valuable educational tool for NASA and AMSAT. Since 1983 SAREX has been connecting school children and teachers to the wonders of Amateur Radio and Space travel. SAREX has evolved into the ARISS program, which currently provides the Amateur Radio equipment and manages the ham radio school contacts on ISS.

After retiring from NASA in 1995, Lou served AMSAT as the Phase 3D integration manager and P3D Laboratory manager. P3D was launched in October 1999 and was designated AO40.

Lou still serves as the ARISS U.S. hardware manager, voluntarily offering his expertise to the ARISS team on a continuing basis in addition to serving on the AMSAT Board of Directors for the past three years. Lou also continues to manage the AMSAT Laboratory in Orlando as well as serving on the Eagle satellite project team. As a part of his duties as U.S. hardware manager for ARISS, Lou managed the U.S. portion of the Suitsat1 project and is now active with the planning for the Suitsat2 project.

BoD Candidate statements continued on next page ...





BoD Candidate statements continued from previous page ...

Lou currently lives in Orlando Florida with his wife, two dogs and a cat. In his spare time he enjoys traveling and visiting with his grandchildren in Houston, Texas.

During his term on the BOD Lou has supported the modernization of the AMSAT database system and accounting system. This project is well on its way as shown by the new face of AMSAT on the AMSAT Web page. Lou has supported and continues to support the AMSAT mission statement and vision.

“AMSAT is a non-profit volunteer organization which designs, builds and operates experimental satellites and promotes space education. We work in partnership with government, industry, educational institutions and fellow Amateur Radio societies. We encourage technical and scientific innovation, and promote the training and development of skilled satellite and ground system designers and operators.

Our Vision is to deploy high earth orbit satellite systems that offer daily coverage by 2009 and continuous coverage by 2012. AMSAT will continue active participation in human space missions and support a stream of LEO satellites developed in cooperation with the educational community and other amateur satellite groups.”

In keeping with that statement, Lou supports the AMSAT Eagle satellite development, The ARISS program, and the AMSAT-DL Phase 3E project.

Bob McGwier, N4HY

I am currently AMSAT Vice President of Engineering and 1st Alternate to the Board of Directors. I am a former multiple-term director of AMSAT. I was the Assistant Vice President of Engineering under Jan King. My involvement in AMSAT activities began in the late 1970's. My serious technical involvement began when I wrote the Quiktrak satellite tracking software package for the Commodore, Radio Shack and then PC computers. I worked on several satellite projects and was a co-designer of the Microsat satellites. With Tom Clark, K3IO, I started the AMSAT/TAPR digital signal processing project. For my roles in AMSAT, TAPR, and the ARRL, I received the Dayton Hamvention Award for Technical Achievement in 1990. I have been with the same employer for 25 years, Center for Communications Research in Princeton, NJ and I continue to love to go to that job every day. I live in East Windsor, NJ with my wife, Shann, N2HPE.

Current activities for AMSAT-NA and AMSAT-DL include P3E, P5A, and I am on the AMSAT-Eagle team. For the AMSAT Eagle project, I am the leader of the transponder design team because we are doing software-defined radio transponders for all modes. I am helping test and write software for the AMSAT-DL P3E and P5A projects using the integrated housekeeping unit (IHU-3).

Recent DSP and software-defined radio activities include authoring the DSP software in the Flex-Radio SDR-1000 with AB2KT. I am the chairman of the ARRL's Software Defined Radio working group and a participant in the GnuRadio project as well as High Performance SDR (HPSDR).

As a strong supporter of the current AMSAT mission statement, I will be a strong proponent of designing, building, and launching satellites that provide many hours a day of satellite passes (HEO, and others) and which provide new technical and learning experiences for our users. I support our statement's goal of helping other organizations in their quest build and launch satellite for low earth orbit. I strongly support the continued AMSAT involvement in the manned space program and will be helping to design upcoming SuitSat equipment.

I am working as hard as anyone in the organization for you right now. And I look forward to working hard for you as a “new old” director.

Lee McLamb, KU4OS

As a new member of the AMSAT Board of Directors I would work to make the Mission and Vision of AMSAT a reality. I am fully committed to the Eagle program and the goal to provide daily and eventually continuous access to satellites in high Earth orbit (HEO). Having multiple satellites in orbit and under construction is the key to avoiding long periods of time during which our gear sits idle while waiting for the next launch. Having a reliable and dependable satellite constellation will also promote membership growth. It will represent a fundamental change as amateur satellites move from a technical curiosity to a useful tool for routine communication, disaster preparedness, experimentation, and education.

To make Eagle and the new AMSAT Vision a reality will require much more than just technical capability. It will also require significant fund raising, membership building and greatly improved communications both within the membership, with other Amateur Radio operators and to those who may be interested in sponsoring or donating to our projects. I believe that I can contribute significantly in guiding AMSAT through this process by ensuring that all of those areas receive appropriate attention. Each one makes a critical contribution to the overall goal of being able to communicate by satellite at any time on any day.

Improving AMSAT's communications both within and outside the organization is very important to me. Within AMSAT I have been an editor for the AMSAT News Service for several years as well as authoring articles for the Journal and papers for the Symposium. I regularly read the AMSAT-BB and follow its discussion threads. One frequently overlooked fact is that ~79% of AMSAT-BB subscribers ARE members. As such I think it is very important for any AMSAT leader to follow the discussion there including the insights that might be gained from the 21% who are not members or maybe members of other AMSAT groups. In doing outreach work for AMSAT I have been donating half of my annual vacation each year mentoring and attending workshops to help educational groups understand the amateur satellite service and AMSAT. I have also been representing AMSAT at conferences where the people developing new launch opportunities for small satellites explain their programs and learning how ridesharing opportunities are negotiated.

Continuing to improve AMSAT's communications and making the Vision of 24/7 satellite availability a reality is why I am asking for and would appreciate your vote for the AMSAT Board of Directors.

BoD Candidate statements continued on next page ...



Dr. H. Paul Shuch, N6TX

“AMSAT is a non-profit volunteer organization which designs, builds and operates experimental satellites and *promotes space education*. We work in partnership with government, industry, *educational institutions* and fellow Amateur Radio societies. We encourage technical and scientific innovation, and *promote the training* and development of skilled satellite and ground system designers and operators.”

The above is AMSAT’s official Mission Statement, straight off our Web site. In *italics*, I’ve added my own emphasis to a few key words. As a lifelong educator (33 years in the classroom), AMSAT’s educational mission is important to me. And, it’s important to your Officers as well. That’s why they recently appointed me AMSAT Director of Education. Help me to help AMSAT fulfill its educational mission, by re-electing me to your Board. The next generation of amateur satellite enthusiasts will thank you.

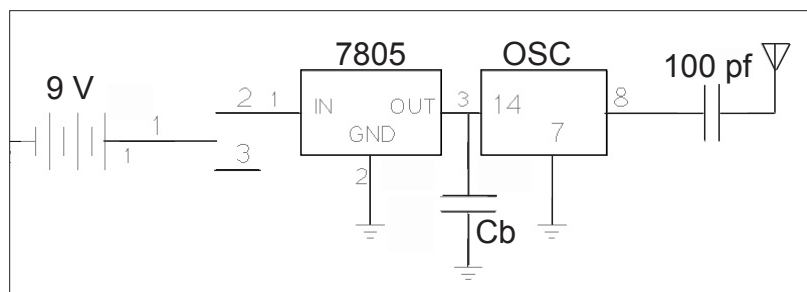
S-Band Generator

A 2.4 GHz Test Generator

By Diane Bruce, VA3DB, db@db.net, AMSAT Area Coordinator

I needed a test signal for testing my 2.4 GHz helix and downconverter. I had quickly lashed one up when I had first put my 2.4 GHz dish up for AO-40, but I decided to redo it when building my 2.4 GHz portable helix. There isn’t a lot to it - a 9 volt battery, switch, 78L05, capacitor and a crystal module from a junked 486 computer board. It’s amazing how far up the harmonics will go from one of those square wave generators; quite high enough and strong enough reach the 2.4 GHz band. This one was marked 24 MHz so I am hearing it on the 100th harmonic. I “liberated” the classy looking dipole from the downconverter I bought from Bob, K5GNA for portable use. The nice tiny case was from a local surplus store in the area.

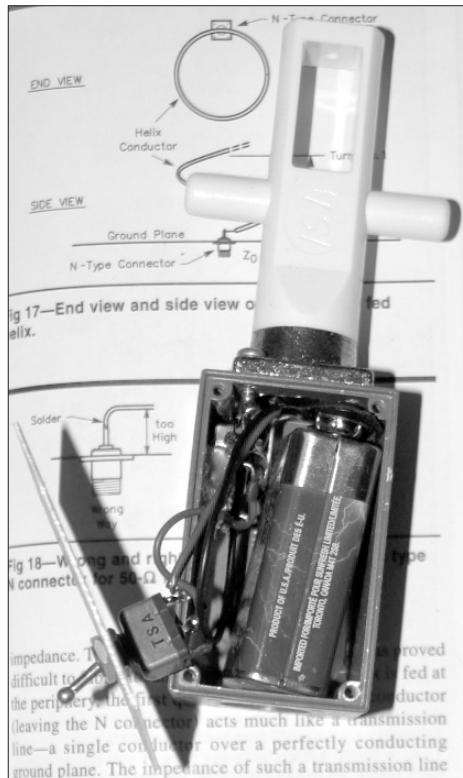
Nothing is particularly critical or original about the schematic. Others have done the same or similar. Capacitor Cb is a 4.7 uf tantalum to forestall oscillation of the regulator. The crystal oscillator module will only have 4 pins but it is counted as though it has 14.



Test generator schematic.



As can be seen from these pictures the test generator is easily assembled in a small enclosure.



Engineering Notebook II

Bob McGwier, N4HY, n4hy@amsat.org
AMSAT Vice President of Engineering

Since my last installment so much has happened it is hard to know where to begin. I was appointed V.P. Engineering in October of 2005. It may seem as if I have been here forever, but I have not reached the end of my first year. I guess I should start at the beginning and then issue a command directive: Warp Factor 9 Mr. Sulu and fire all phasers! And even with that, I have time and room only for the two biggest topics.

Phase 3 Express

In December, Frank Brickle, AB2KT, Lyle Johnson, KK7P, Howard Long, G6LVB, and I traveled to Marburg, Germany to a design meeting with the Phase 3 E team. Karl and I spent days working on the IHU. We got the basics of IPS system running on the IHU-3. Karl was tremendously helpful and I am extremely grateful to have had those days of interaction with him. While we were there, we discussed the Software Defined Transponder, SDX, with the Phase 3 Express management and with Karl. They liked it and have adopted it as an official project goal. Karl became convinced and gave us a tour de force lecture on HELAPS and SDX. Karl made a side comment to me that it appeared the two organizations were working more closely with each other all of the time. I agreed and left it there.

It has been a long six years since AO-40 was put on top of an Ariane. Many changes have occurred in both organizations. The biggest change is in AMSAT-DL. Karl is not the president. Karl is not a director. His role on Phase 3 E is as advisor. Peter Gülzow, DB2OS, is president of AMSAT-DL. Werner Haas, DJ5KQ, is no longer director of AMSAT-DL. He will no longer design our HELAPS transmitters. He will not be on

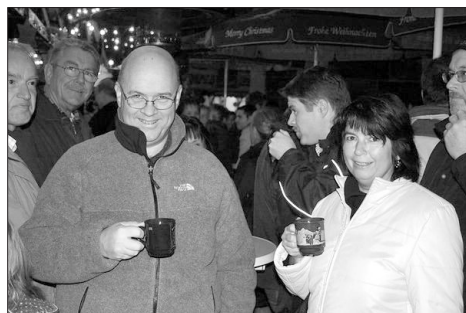


Figure 1: N4HY, VP Engineering, and Heike Straube, P3E Project Manager, with ZEL colleagues warming up in Marburg at an outdoor Christmas event.

the P3 team in any way. Werner is a silent key. Heike Straube, a long time member of the staff of Zentrales Entwicklungs Labor für Elektronik (ZEL) at Phillips University in Marburg, has been made P3E Project Manager. She is doing a good job. That said, the ZEL is not without its problems. It is making its last stand. Phillips University in Marburg has declared that upon Karl's mandatory retirement, he will not be replaced as its leader and it will close. That has been forestalled for a bit but it is inevitable.

So, AMSAT-NA members are doing the IHU, the spacecraft bus and the Mode B transponder "innards" with SDX and this includes an advanced form of HELAPS for efficiency. AMSAT-NA has new executive leadership. It has new engineering leadership. AMSAT-DL has new executive leadership and a new Project Manager. We have a world shrunk by communications systems we only dreamed were possible in the 1990's. We could probably do more and we could certainly do it better than we have ever been able to before. Should we?

I am working about as hard as I can to get AMSAT-NA and AMSAT-DL to sit down, write down an agreement, which would allow AMSAT-NA to participate fully in the development, launch, and mission for P3E, as official project partners. AMSAT-NA and all radio amateurs need P3E to succeed. We need it as much as AMSAT-DL needs to succeed doing it. Several of us believe AMSAT-DL will be able to do better with our help and it is in our interest to do so. This is an AMSAT-DL mission but WE need it. I could easily work for Peter and Heike. They are terrific people. I believe they need us and I want us to help. I believe that should I fail getting this rapprochement to occur, my tenure as the engineering executive will be a failure since all of Amateur Radio and AMSAT-ALL will be the loser.

AMSAT Eagle

Shortly after I returned from Germany, in my third month in the AMSAT V.P. Engineering

job, just as it was becoming apparent that we needed P3E, and we needed to help, my engineering notebooks began to become full of thoughts and calculations that showed the AMSAT Eagle design which had been worked on for years was not going to work. Karl helped me tremendously with mechanical calculations. Dick Jansson, Karl and I exchanged lots of design information and calculations. Jan King helped me tremendously with link budget analysis. They vetted my entire thought process. Thank goodness! Maybe I had not forgotten that much in my fifteen year absence.

Warning: Honesty Follows

Eagle's design was born in fear. We were afraid of anything complex. We were never



Figure 2: G6LVB, KK7P, DB2OS and AB2KT discuss SDX.

going to attempt anything that reminded us of our mistakes in engineering management, which occurred in the AO-40 program. In short, the guidance provided to the current designers had more to with fear than with physics. We were trying to force a large satellite program onto a large microsat. Roughly 3 times the size of a Microsat (on



Figure 3: Rick, W2GPS, AMSAT Pres, John, KD6OZH, Eagle 70 cm RX designer and N4HY AMSAT V.P. Engineering in San Diego as we listen to Rick's opening remarks on the organization goals.



Figure 4: (L-R) N4HY, KK7P, N0ADI, N6NKF, AB2KT at San Diego, 2006.

each edge), we were attempting to do a lot with this package. The organizational leadership wanted us to move into the future of digital communication with digital voice and video supported. We wanted to use those lessons Phil Karn, KA9Q, taught us with the FEC on AO-40 and to provide for low bandwidth, small power stations. Phil has given us a grant towards the design of the ground station to support such a mission. The bottom line, nothing about the design we had was going to support the program we wanted. We needed versatility in the design. We needed a design that could support either a 200 N bipropellant motor (like other P3 satellites) or if we wound up launching from near the equator, we could decide not to use a large thrust motor. The structure we designed could not have been made to support such a large thrust. Even without a significant motor, its damping would have required hundreds of orbits to stabilize any “wobble”. We were going to attempt that which requires more engineering moxie than we had: fold out solar panels. We were, in my mind, attempting risky things out of fear of complexity and not making good system decisions. In engineering circles I started saying we were learning the wrong lessons from our previous design successes and failures. But, to be honest I was not gaining real traction.

I believed that the microwave digital experiments required more power than we could generate with the initial design given my preliminary analysis based on link analysis spreadsheets written by Jan King. The microwave digital experiments could not be supported on a three-axis stabilized platform (antenna rotator in space) because we are incapable of designing and building

the sensor package it would take to support such a spacecraft. We could not come close to affording those sensors in a complete package if we could find a supplier. This meant we had to steer the spacecraft antennas electrically or we were going to have to give up on those digital dreams. This meant we needed phased arrays. Fear of this complex

antenna outstripped the need for it and we did not investigate how technology had changed. We had lots of knee jerk reactions. In fact, it appears the parts to do the phasing are commercial, off the shelf, and cheap. We were distracted and indeed paralyzed for months with a proposal to save antenna space that in my mind was never going to work by using the same antenna for uplink and downlink. I needed consensus and it was clear I was not getting it. We were stuck. I was involved in breaking firmly entrenched beliefs about what we could or should do. I was advised to be a dictator, but that is not my style. I stalled. I hated it, but I stalled. Anyone who knows me personally knows I am not a stalling type.

I began to see the pieces fall into place in April. In May, the SDX worked beautifully at Dayton. I called a design meeting for June. I restricted its attendance to those I believed could do dispassionate analysis. What we needed was the bottom line irrespective of past occurrences. We needed to know what was possible and how we could do it.

I recruited an all-star team and I believe we succeeded. We met in San Diego in June this year, in space arranged for us by our long time AMSAT member and friend, Franklin Antonio, N6NKF, (author of InstantTrack). We went over the cold hard facts and calculations. We allowed physics to lead us. And with a great detailed straw man by Matt Ettus, N2MJI, it led us quickly to the bottom line. The Microsat-plus cube would never support the mission. With a rough estimate of the power budget and direct calculation on the needed antenna gains, we needed twice as much power and about seventy percent more antenna space than the initial design would support. In fact, we were going to have to require a 60 cm dish on the ground for digital voice. We could not afford to have the slow data, low power stations on microwave ruining our dream. They would consume half the power! We needed a credible U/V Mode B transponder to support the small no antenna pointing digital system as well as supporting our linear transponder users. We needed real antennas for both bands. The SDX could do both jobs. I left San Diego on a technical high. We have great people in AMSAT. It is a daily honor to work with such people. We have added to our pool of talent with significant new volunteers in the last few months. In the coming weeks, expect to hear from Eagle project management on all of the details and of course, you can watch the increasing documentation appearing on EaglePedia.

Shortly after I wrote installment one of this column, I did not know if there would ever be an installment II or if I would survive the year. Now, I believe I might. I think we have a plan at last and I think I will like this job more during the coming year than last! Your support is needed and your comments are welcome. ☺



Figure 5: (L-R) N0ADI, AB2KT, N2MJI, K3IO, K7GNU, WB4GCS (Eagle Project Manager).



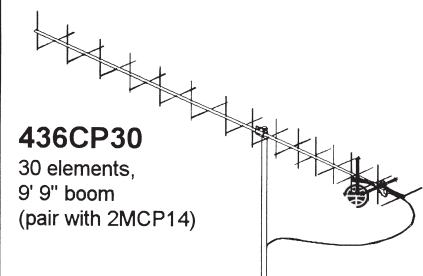
M² YOUR SATELLITE ANTENNA SOURCE

NEW!
Ultra-gain!



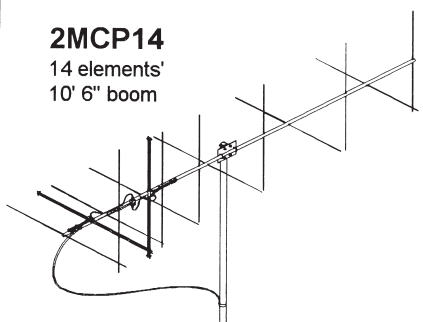
436CP42-U/G

42 elements,
18' 10" tapered boom
(pair with 2MCP22)



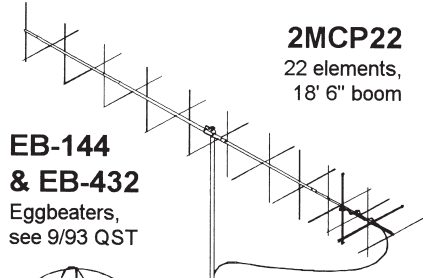
436CP30

30 elements,
9' 9" boom
(pair with 2MCP14)



2MCP14

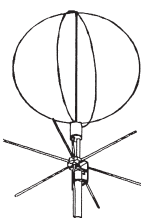
14 elements,
10' 6" boom



2MCP22

22 elements,
18' 6" boom

**EB-144
& EB-432**
Eggbeaters,
see 9/93 QST



- Stacking frames
- AZ & EL positioners
- Fiberglass crossbooms
- Power Dividers
- Phasing harnesses

M² 4402 N. Selland
Fresno, CA 93722
(559) 432-8873 FAX: 432-3059



AMSAT is the North American distributor of **SatPC32**, a tracking program designed for ham satellite applications. For Windows 95, 98, NT, ME, 2000, XP.

Version 12.4 now supports Labjack U12 and W0LMD rotor controllers and Doppler tuning for Yaesu FT-817/857/897.

Version 12.5 now available!

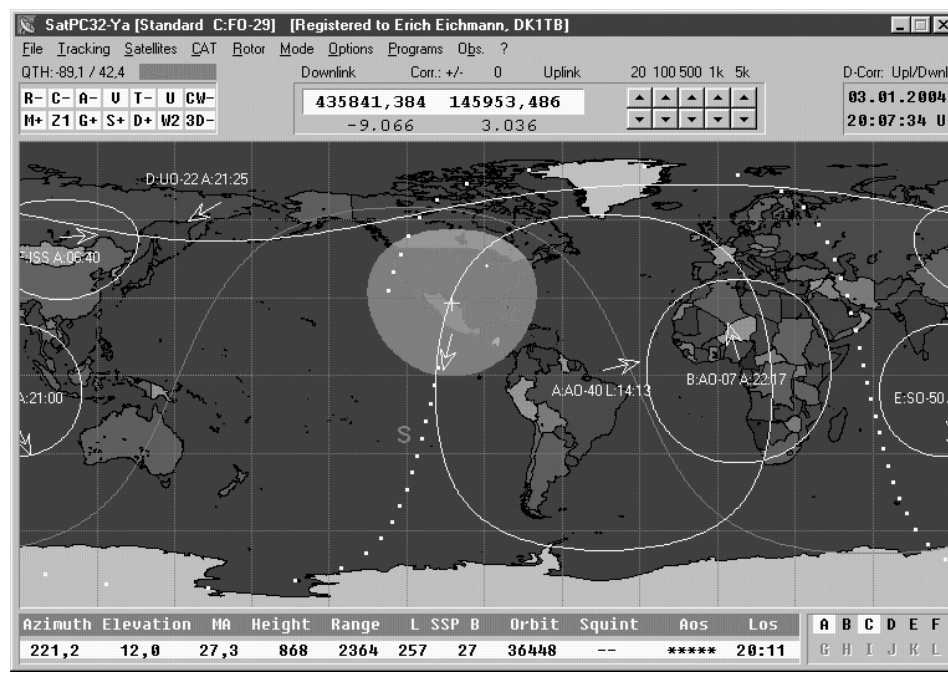
Features:

- Version 12.4 also supports automatic Internet download of Keplerian elements.
- Graphical tracking on a world map with two selectable Zoom factors.
- One-click satellite switching using 12 "letter" buttons.
- Automatic rotor control support for: Kansas City Tracker/Tuner, FODtrack, Uni_Trac, SatEL, Labjack U12/Piggyback, W0LMD Mini/Junior/Senior Trackers, Yaesu GS-232, ARS from EA4TX, EGIS rotors, IF-100, RIF-PC, AMSAT-DL interface, WinRotor32, HalloRotor, and WiSP DDE clients.
- Doppler tuning with on-screen frequency displays. Radio models supported:
Yaesu FT-847, FT-736R, FT-817, FT-857, FT-897
ICOM IC-820H, IC-821H, IC-910H and other ICOM radios
Kenwood TS-790 and TS-2000
DDE client programs
- "Transparent" VFO-knob tuning in addition to keyboard and mouse tuning.
- "Virtual" VFO tracking for half-duplex transceivers FT-817, FT-857, FT-897.
- Includes a special version for ISS split-frequency operation.
- Controls subaudible tone on FT-847, FT-736R, FT-817/857/897, and IC-910H.
- Includes a non-graphical version and programs that output lists to the screen, printer, or a file.
- Interfaces with WiSP, with user-defined satellite switching priority.
- Includes a separate program for tracking the Sun and Moon.

Price is \$45 for AMSAT members, \$50 for non-members, on CD-ROM.

A demo version may be downloaded from <http://www.dk1tb.de/indexeng.htm>
A registration password for the demo version is \$40 (members), \$45 (non-members).

Order by calling 1-888-322-6728, or use the online shop at www.amsat.org.
The author DK1TB donated SatPC32 to AMSAT. All proceeds support AMSAT.





23rd AMSAT® Space Symposium and Annual Meeting
October 6-8 2006
A Joint Meeting with the IARU Satellite Advisors and AMSAT International
and a Meeting of the Amateur Radio on the ISS International Delegates (October 9 and 10)

Hotel:

The Symposium will be held in the Crowne Plaza located in Foster City, CA (10km south of San Francisco International Airport). The hotel offers broadband internet, indoor pool and sauna, whirlpool, exercise room, full service restaurants and a sports lounge. You can register online at the AMSAT website or contact the hotel at (650) 570-5700. Be sure to indicate you are with AMSAT to qualify for the **special room rate of \$109** per night. **Please use the group booking code AMS.**

Airport Information:

San Francisco International Airport is located 10km north of the hotel. The hotel provides free shuttle bus service to and from the airport. Oakland International Airport is located across the bay approximately 25km away and San Jose International is located approximately 30km away to the south. See the AMSAT website for transportation to and from Oakland and San Jose.

Train and Bus:

Foster City is served locally by CalTrain and SamTrans. AMTRAK provides service to San Jose and San Francisco (via Emoryville) with connections to CalTrain. SamTrans has local and express buses to and from San Francisco. Local bus service runs from 6:30am to 11:30pm. Fares are \$1.50 except for buses **FROM** San Francisco, which are \$3.00. Senior discount is 50%.

Family Fun and Excursions

No formal tours are planned however tours of San Francisco and Monterey including the Monterey Bay Aquarium, Fisherman's Wharf, Union Square, Alcatraz, and Cable Car excursions are available. Please see the AMSAT website for more information.

Sunday Tour of NASA Ames:

On Sunday from 12:30pm to 4:30pm we have arranged for a trip to NASA Ames Research Center Exploratorium Center. Here you will be able to experience NASA technology and missions first hand including the largest Immersion Theater on the west coast. Admission is free, but there is a \$15 charge for bus transportation to and from the hotel.

Description	Cost	How Many	Amount
Registration (Includes Conference Proceedings)			
Until September 15, 2005	\$45.00		
After September 15, 2005	\$55.00		
At the Door	\$65.00		
Saturday Night Banquet	\$35.00		
Indicate Meal Preferences (Quantities)	___ Prime Rib ___ Vegetarian		
Area Coordinator's Breakfast	\$10.00		
Sunday Tour to NASA Ames (inc. bus)	\$15.00		
Make checks payable to AMSAT-NA in \$US		TOTAL	\$
Visa/MC/AMEX/Disc.		Expiration:	

Print Name: _____ **Call:** _____

Print Name: _____ **Call:** _____

Print Address: _____

Print City: _____ **State/Prov:** _____

Print Zip/Postal Code: _____ **Country:** _____

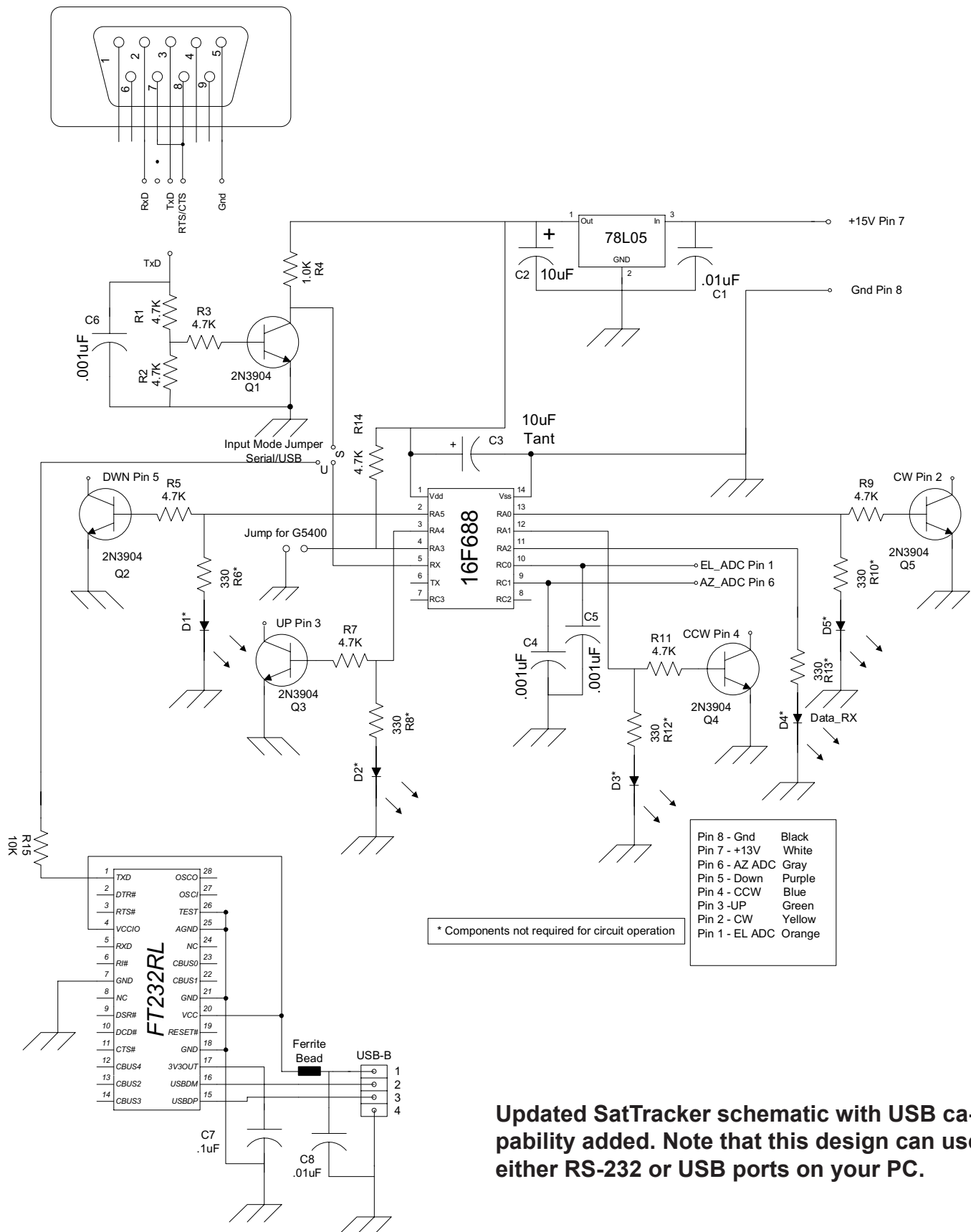
Daytime Telephone: _____

Send to: AMSAT
850 Sligo Ave. # 600
Silver Spring, MD 20910-4703

Telephone: +1 (301) 589-6062
Fax: +1 (301) 608-3410
Email: martha@amsat.org



Satellite Tracker Interface Using PIC16F688 for Yaesu G-5500 or G5400 and NOVA or SatPC32 Figure 1



Updated SatTracker schematic with USB capability added. Note that this design can use either RS-232 or USB ports on your PC.



A High Efficiency S-Band Power Amplifier

by Marc Franco, N2UO

edited by Jim Sanford, WB4GCS

One of AMSAT's missions is to promote space education and to partner with educational institutions and industry. For that purpose, it was decided during an Eagle RF design team meeting to work with undergraduate students of The College of New Jersey (TCNJ) to develop the prototype of the 2.4 GHz RF power amplifier for Eagle. This meeting took place at Linearizer Technology, Inc. (LTI) facilities in Hamilton, New Jersey, over the Thanksgiving weekend in November 2005 (see *The AMSAT Journal*, January/February 2006, page 29). LTI is Dr. Allen Katz's, K2UYH, company. Allen is also a professor of electrical engineering at TCNJ.

We started to work with two undergraduates, Nick Vacirca and Steve Hendrickson. We met every Wednesday and went from "zero" to designing, simulating, building and tuning a 5 W amplifier with a Gallium Nitride FET, the latest technology in RF power devices. We had AMSAT's VP of Engineering, Bob McGwier, N4HY, attending most of the meetings. He lectured on software defined transponders and satellite orbits so that the students could have a better understanding of Eagle.

Steve Hendrickson continued working on the power amplifier after the special topic class ended. We entered his design in this year's power amplifier efficiency student competition at the IEEE International Microwave Symposium, in San Francisco in June 2006. The rules for the contest were simple: build an amplifier that has the highest power added efficiency, with no more than 25 dBm input, frequency within 1 to 20 GHz, and 5 W minimum output power.

The Eagle amplifier design achieved over 61% efficiency. Since the other entries were down at 1 GHz (and as a result, more competitive in terms of efficiency), we did not win, but Steve received a special recognition for his good results at 2.4 GHz, and for being the only undergraduate student. The judge was Dr. Steve Cripps, a very well known author, and world expert in amplifier design.

At the Symposium exhibition we had the chance to meet with the manufacturers of the device (Eudyna, formerly Fujitsu), including the engineer who actually designed the device we used.

So far, this work has been done at no cost to AMSAT since we used a sample device, a fixture that I provided and LTI support (Steve does part time work and I lead the design of advanced products at LTI). LTI has a 1,000 sq. ft. class 10,000 clean room, with wire bonding capability and a lots of state-of-the-art microwave test equipment, which they've made available to AMSAT.

We will continue working on this amplifier with Steve and, hopefully, other students joining the effort. The plan is to improve the efficiency to get close to 80% and enter next year's student competition at the IEEE International Microwave Symposium to take place in Hawaii. This amplifier is non-linear but it can be amplitude modulated in an envelope elimination and restoration system (EER, otherwise known as HELAPS) to achieve high efficiency linear operation. We are using a 30 V drain voltage and the device breakdown is 120 V. This gives us lots of margin to failure, at very little cost in gain or efficiency. ☺



Photo 1: Dr. Marc Franco, N2UO, and Steve Hendrickson, The College of New Jersey student, with Eagle's 2.4 GHz prototype amplifier at the Student Award Banquet during the IEEE Microwave Symposium in San Francisco, June 2006.

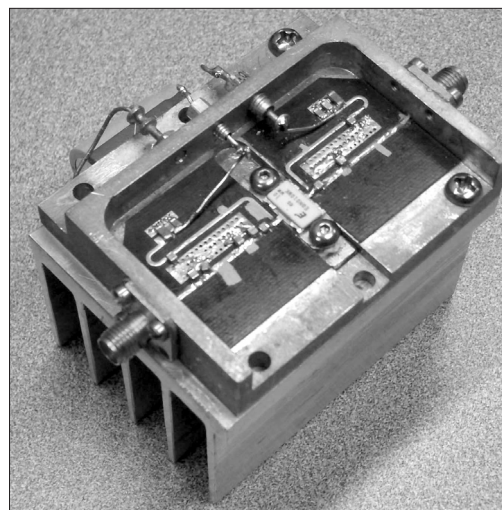
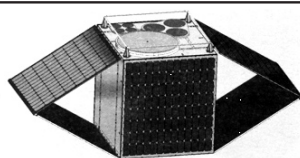


Photo 2: Steve Hendrickson's honorable mention-winning prototype amplifier.



AMSAT Eagle Project

How You Can Help Build New and Exciting Satellites

Donate to the President's Club

Gold, Silver, Bronze and Core levels are available to match your ability to participate.

Cash Gifts

Visa or MasterCard or checks are accepted. And, you can specify how your contribution is to be used.

Gift of Life Insurance

US taxpayers may be able to receive a significant income tax deduction by making The Radio Amateur Satellite Corporation the owner and beneficiary of life insurance policies.

Gift of Stocks or other Securities

US taxpayers should be able to avoid gains taxes on appreciated securities and receive a deduction for their fair market value.

Bequest

A codicil in your will, naming The Radio Amateur Satellite Corporation as a beneficiary, will help insure the continuance of the Amateur Radio Satellite program.

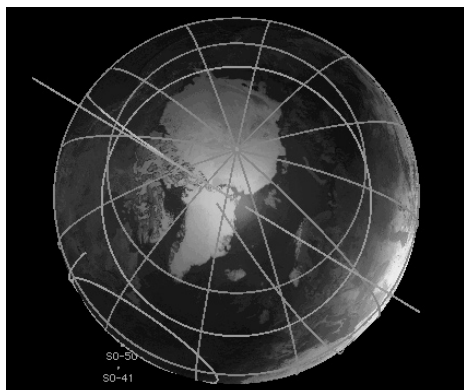
Call the AMSAT-NA office at **301-589-6062** for questions on any or all of these ways you can help build new and exciting satellites.

Support AMSAT-NA



MacDopplerPRO X

The premier Satellite tracking and station automation application for the Macintosh - OS 9 & OS X



MacDopplerPRO X gives you a seat right in the heart of the Operations & Command Centre for every satellite in orbit. In fact up to thirty two front row seats at the same time, providing any level of station automation you need from assisted Doppler Tuning and Antenna Pointing right on up to fully automated Satellite Gateway !

It will calculate the position and relative velocity of the satellite you are tracking and automatically adjust the Doppler shift on both transmit and receive as well as pointing your antennas with predictive dead spot crossing so that a pass is never interrupted by the beam heading passing a dead spot.

MacDopplerPRO X provides separate windows for the map (2D or 3D), the radio controls, and the sorted table of upcoming satellite passes. A Horizon window graphs upcoming passes as a function of elevation over time for status at a glance.

Now available at a special member discount price from AMSAT !

martha@amsat.org
850 Sligo Ave.,
Silver Spring MD,
20910-4703 USA.
(301) 589-6062, (301) 608-3410 (Fax)

Dog Park Software Ltd.
www.dogparksoftware.com

Do you still use manual tuning to remove Doppler changes? Why not automate? **Uni-Trac 2000** will automatically tune your Receiver (and Transmitter) to compensate Doppler frequency changes. Uni-Trac will also **STEER** your Antenna !

Uni-Trac 2000, including Interface Cable \$280.00
FOB Concord, Mass. 01742, USA.



Spectrum International, Inc.,
P.O. Box 1084,
Concord, Mass. 01742, USA.
Tel: (978) 263-2145
Fax: (978) 263-7008

SSB ELECTRONIC USA

PHASE 3D Equipment Headquarters

SSB Electronic USA features world class VHF - UHF - SHF equipment. The latest gear from: SSB Electronic, Kuhne Electronic - DB6NT, M2 Antennas, Beko Electronic, EME, Procomm, AIRCOM PLUS, AIRLINK, ECOFLEX and WINRADIO is available.

- Mast Mounted Preamplifiers 144 - 2400 MHz.
- Ultra Low Noise LNA's 50.0 MHz. 24.0 GHz.
- Transverters 50 MHz. - 24.0 GHz.
- Antennas - Rotors
- Downconverters and TX Upconverters for all P3D frequencies
- Mode "S" Downconverters
- Mode "L" TX Upconverters
- Linear Amplifiers 50 MHz. - 24.0 GHz.
- Ultra Low Loss Coaxial Cable
- Transverter Kits 1.2, 2.4, 5.7 & 10 GHz.
- Parabolic Dishes

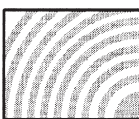
So What's New ?

BEKO Electronic: 144 MHz. - 1296 MHz. Linear Amplifiers 100 Watts - 1200 Watts

DB6NT Electronic: MKU 24 OSCAR Mode "S" Downconverter IF 144 or 432 MHz.
MKU 10 OSCAR 10.451 GHz. Down Converter
MKU 24 G2 OSCAR 2.4 GHz. Transverter 1 Watt
MKU 57 OTX 5.6 GHz. OSCAR TX Upconverter *plus more.....*

ECOFLEX - LLC Super Flexible Low Loss Coaxial Cable

SSB Electronic: UEK-3000SAT Mode "S" Downconverter IF 144 or 432 MHz.
UTM-1200 DLX Mast mounted 1269 MHz. 15 Watt TX Upconverter
UTM-1200-1 1269 MHz. 1 Watt TX Upconverter
SP-2000 & SP-7000 Heli-Filtered Mast-Mounted Preamps *plus more.....*



SSB
Electronic USA

For complete specifications and prices, please visit our WEB SITE: **www.ssbusa.com**

Phone 570-868-5643

New Hours: MTWTFSS
9:00 AM - 11:00 PM

124 Cherrywood Dr.
Mountaintop, PA 18707



A 2.4 GHz Helix for Portable Use

by Diane Bruce, VA3DB, db@db.net, AMSAT Area Coordinator

Introduction

When I first saw Clare Fowler's, VE3NPC, helix for 2.4 GHz at the 2005 Field Day for the OARC (<http://www.oarc.net>) it looked simple enough and I decided I could replicate one. However, there were no documented, easy-to-follow instructions, so I had to use photos of Clare's antenna and the ARRL Antenna handbook. I felt that perhaps others would be interested in how I put my version of this helix antenna together. Since frequencies are given in metric terms, I worked out sizes in metric and then use these with a metric rule. I will give measurements in both metric and imperial (rounded up) in this article.



Photo 1: Photo of Clare's, VE3NPC, original helix.

Finding the Mechanical Pieces

I had a piece of aluminum plate left over from another project that was about 3/32" (4mm) thick. It had a round cut in one end which was left over from a patch I had built for 2.4 GHz, but it had a good piece of 6"x6" (15cm x 15cm) left. The thickness is not crucial, but has to be thick enough to support all the hardware. If you use anything much thicker, it will be more difficult to cut. I bought this piece at a hobby store a few years ago; however I have seen aluminum plates for sale at hardware stores. Clare used a piece of fiberglass square rod to support the actual helix itself. This material is used in chain link fencing and this can also be

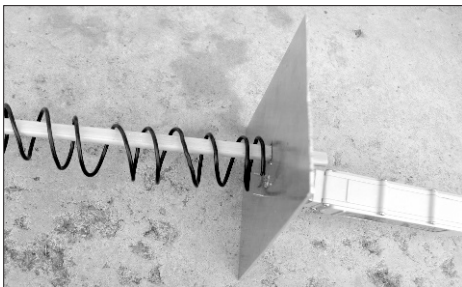


Photo 2: "Eyeball" layout on the front steps.

found at many hardware stores. My piece is about 1/2" by 1/4" (1.25cm by 6mm), it comes in two lengths; the shorter length is plenty for this project. I have to agree with Clare, this material is very light but strong and is easily worked. I also needed some flexible brass for the matching section. This also was left over from my previous patch project but is also easily attainable at hobby or hardware stores.

Finding the Electronic Pieces

Now that I had all the mechanical pieces, it was time to find all the electronic pieces. I ordered an AIDC 1731 from K5GNA with the low drop out regulator since I intended to use this portable. I wanted to be able to run the system on a 12 volt gel cell. I also ordered his voltage injector as it just did not seem worthwhile to build my own. I had a male chassis type N connector kicking around in the junk box, again left over from the patch project. You could easily substitute a female type N and use a type N male to male barrel to connect to the downconverter.

Putting it All Together

I started out using the ARRL Antenna Book, but I followed the advice given by Clare (more or less) as his antennas seem to work!

Ground Plane (Backplate)

I started out with the ground plane. According to the ARRL Antenna Book, it needs to be 0.8λ to 1.1λ at 2400 MHz. This works out to approximately 10 cm to 13.75 cm (4" to 5.5"). I had a piece of 6" (15 cm) aluminum, which I squared to roughly 6" by 6" (15cm by 15 cm) and scored it from corner to corner to find the middle of the plate. The observant reader will note this is a tad larger than that recommendation in the Antenna Book and could result in larger lobes, but it saved me cutting twice and I felt I'd really not notice a small performance change in portable use. I drilled a few holes at the center and started filing a hole for the fiberglass support rod. This was by far, the most time consuming portion of the project. I could not get a metal nibbler in the hole; it was much too small. Those of you with Dremel tools can make quick work of this. Clare had used a piece of aluminum ground wire for the helix, I decided to use a piece of copper wire as to simplify the connection of the helix to the type N connector. Certainly a piece of aluminum ground wire would make this

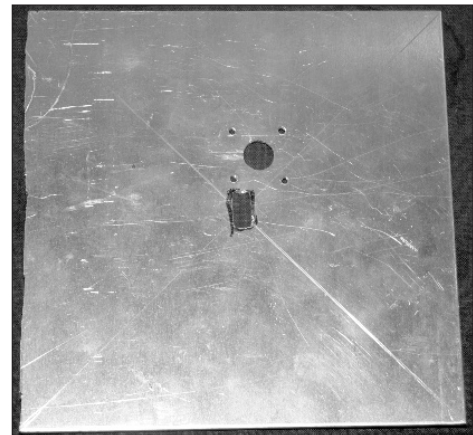


Photo 3: Back plate with fiberglass support rod hole and holes for type N connector.

lighter but for a single helix I decided I would make it easier instead of lighter. I followed Clare's advice to follow the original Kraus design rather than the ARRL handbook so the circumference should be about 1λ or

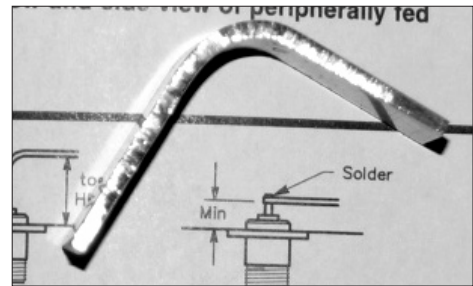


Photo 4: L-bracket. See text.

about 12.5 cm (5") in circumference or 1 1/2" in diameter. I wound my helix using a piece of pipe that happened to be close to the right size and let it pop out a bit. This set where I would have to place the center pin of the type N connector. Eyeballing the center



Photo 5: Method of holding the support rod and L-bracket in position.



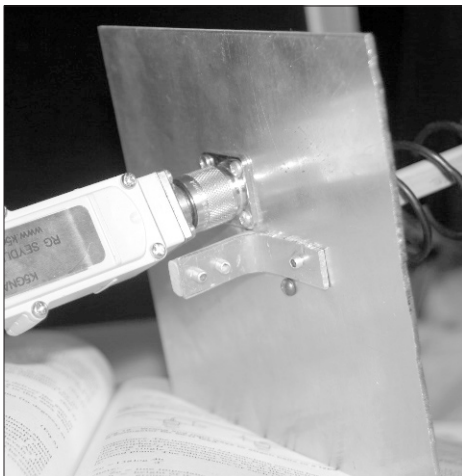


Photo 6: L-bracket pop-riveted in position.

of the helix, I used this to guide where to drill the center hole for my connector.

Support Rod

The next step was to support the fiberglass support bar in the middle so I could support the helix to the support bar and solder the helix to the connector. The pitch according to Clare should be 12.5° between turns, but I chose 3cm as it was a nice round number. This meant my fiberglass rod had to be about 36cm (about 14.25") from the ground plane to the end plus a bit left over for a L bracket. I cut mine to a little over 39cm or about 15.5". Modern day fiberglass is considerably better than the original fiberglass but I still would advise that you be careful not to breathe the dust from it as it is cut. Once cut, the fiberglass rod was considerably lighter and much easier to work with.

L Bracket

In keeping with using up scrap pieces, I decided to make my L bracket from what there was left of the hobby store aluminum plate. I eyeballed it to give me about 3cm each side of the "L". Depending on how hard your aluminum piece is, be careful that you do not try to bend it with too small a radius, it will break. (Yes, I made this mistake.) You will note in the photo the bend radius I used the second time.

I held the L bracket onto the ground plane with a vice and a pair of vise grips then drilled a pair of holes and cheated using some pop rivets to hold the L bracket and fiberglass support together. The helix was then tied to the support boom using some tie wraps and cut up pieces of an old plastic pen. I drilled holes at 90 degrees to each other at each end and tied to the boom and wire as needed, this is a trick I stole from Clare. The matching section is a piece of brass that is brought around $1/4\lambda$ making the first turn in fact, a $1/4\lambda$ transmission line matching the helix impedance to 50ohms. I goofed a bit on this part, however as Clare points out, it is fine for receive.

Conclusion

Even those with all thumbs can construct a portable helix, if I can do it, you can! I also have to thank Clare, VE3NPC, for his advice, and allowing me to take photos of his original. 🌐



amsat.org

Echo's Versatility?

Check this week's configuration

See: Echo Control Team Schedule
on www.amsat.org

Wednesday is "experiment day"

Try it, you'll love it !

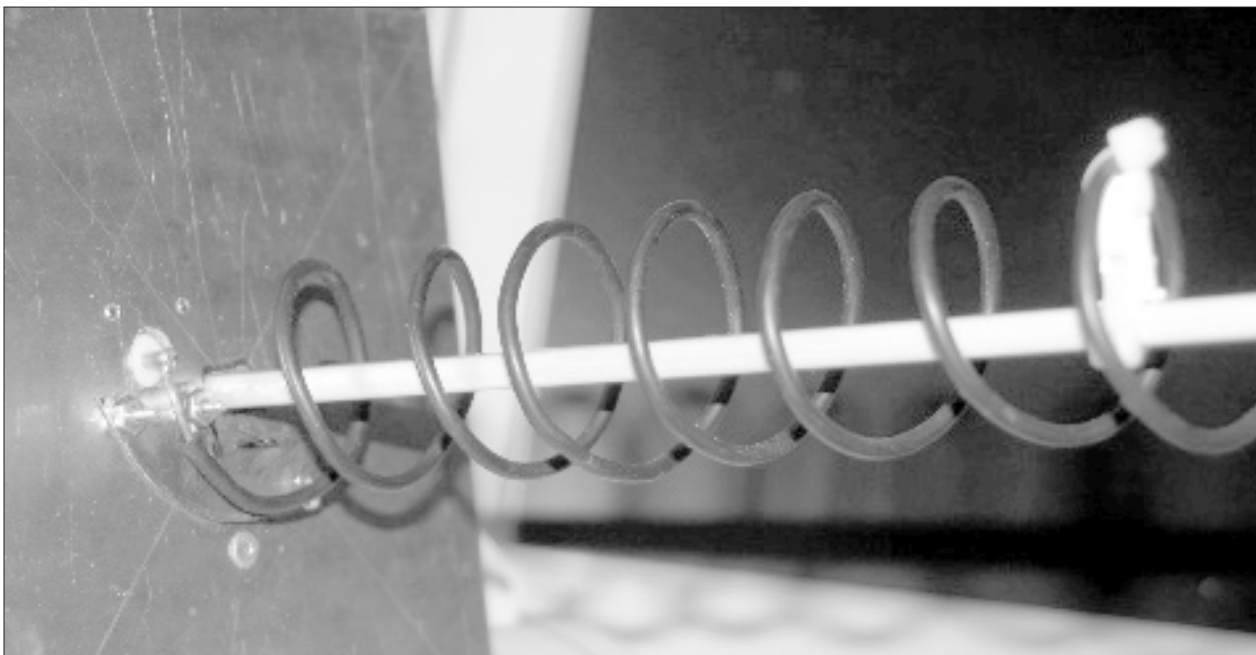


Photo 7: Tie wraps and spacers are used to support the element above the support rod.



AMSAT Field Day Report

by Bruce Paige, KK5DO, kk5do@amsat.org

Once again Field Day has come and gone. There were some areas that were hot and dry, some hot and humid areas and some places where it was just perfect. By the reports that have been sent in, it looks like everyone had a really good time. In 2005, there were 11 participants that submitted entries. This year participation nearly doubled, we had 21. In 2005 also we had one more satellite (AO-27) than this year. Total reported contacts last year were 144 with VO-52 carrying 42 contacts. This year, we had 327 contacts reported and FO-29 carried 88 contacts.

Okay, so, how did everyone rank? Topping the list was the Lafayette DX Association, W9LDX, with 55 contacts. Second place goes to Los Chupacabrados, N5JO, with 43 contacts. Third place goes to NX2Q with 36 contacts and a close fourth goes to Raytown ARC, K0GQ, with 35 contacts. The only home station reporting was W6GMT. We also had one EOC reporting, Boca Raton ARA and Florida Atlantic University ARC operating as N4EN.

Here are some reports from the field and some really great pictures.



Above: Angel, WP3GW, doing a satellite demo with Aris, WP4DX (l), and to the right Francisco, NP3OD, and newcomer Orlando, WP4NPV.

Below: From the U.S. Forest Service campground at North Star Lake in MN, W6GMT operated as a 1E for Field Day this year using his Honda generator as the power source during the day and batteries during the quiet hours in the campground.



Below: Diane, VA3DB, was out with OARC, operating as VE3RC. She said, "We made our first contact on FO29 with the borrowed 847 and my TH-F6 on receive." Field day Murphy struck, we did not have a BNC to type N connector. But with VA3DB on the key, we did make one CW contact on FO29.



Right: This year was quite possibly the first time the Motor City Radio Club (W8MRM) made an FM satellite QSO on Field Day! It seemed much easier to get into that satellite compared to previous years. Our only other satellite QSO was on FO-29. We tried to use the ISS, but had no luck hearing ourselves, nor any other complete calls. With this antenna setup, contacts should have been a snap. Just look how much closer their antenna is to the satellite.





Below: After several attempts on other satellites to make a field day QSO, Joe, KC8RAN, operating as WB8CQR, had this to say about AO-7. “Heads, I win! Mode B! After some adjustment for Doppler, I tried to make a CW contact. The excitement and the rust really came into play as I was awful with the paddles. Switched to SSB and finally was able to work W9LDX for the satellite QSO, after remembering to switch to the correct sideband on the uplink!”



Pictured on the right from the W5MSQ field day site east of Houston, the setup was quite different. Here, visitors from all over could come and visit. Not all were able to try their luck at making a satellite contact, but they still found the satellites interesting, even the four legged metal men with no head.



Right: At the K6AA field day site located at the Upper Reservation of historic Fort MacArthur in San Pedro, CA, Jim, KQ6EA, (r) and his son Flip, KF6WVV, (l) take a break from assembling their modest but simple egg beater receive antennas.

With his simple setup Jim said, “For the first time at Field Day, I had people calling me! Quite a thrill to have somebody jump in after I completed a contact.” After everything was said and done the only thing Jim had left to say as, “All-in-all, this was my best and most rewarding Field Day satellite operation.”

Next year, I hope that we have even more participants in the AMSAT Field Day.

73 and Good DX,

Bruce, KK5DO 📶



AMSAT Field Day Scores

W9LDX	55
N5JO	43
NX2Q	36
K0GQ	35
K4CQ	34
W0MA	19
W9NE	18
W5MSQ	16
W5IU	13
N4EN	11
W0BU	10
W6GMT	8
VE3RC	7
K3HKI	6
W8MRM	4
K6AA	3
WD9EWK	3
WB8CQR	2
W6ZQ/7	1
W8IJ	1
WP3GW	1



The Orbital Classroom - "1000 cc Science"

© 2006 by Dr. H. Paul Shuch, N6TX, n6tx@amsat.org

AMSAT Director of Education



The Orbital Classroom

Do you think maybe you'd like to build a satellite, but are not quite sure where to start? That was the situation facing engineering students at Cuesta College on the Central California coast a few years back. Cuesta was well suited to host a satellite program, being just under an hour's drive from the US Western Test Range launch facilities at Vandenberg Air Force Base. Our earliest OSCARs had been launched from Vandy. Two Cuesta faculty members, Cliff Buttschardt, W7RR, and Ed English, W6WYQ, had been OSCAR-active since the dawn of the space age. Space was clearly the place. Only, where to start?

The students' confusion was understandable. It stemmed from the simple fact that every ham satellite to date had been custom-designed around a specific launch opportunity. It was common practice to fit a piggyback payload into a well-defined nook or cranny on a particular vehicle. OSCARs 1 and 2, for example, had semi-pyramidal bodies with curved top surfaces, optimized in mass and form factor to serve as ballast for military AGENA satellites. Only, the Cuesta students and their advisors had no particular launch in mind. They wanted simply to build a ham satellite, stick out their thumbs, and hitchhike into orbit.

Ed and Cliff had an answer, though it involved a clean break from past practice. Why not, they proposed, come up with a standard package for a small satellite, one compatible with launch from a wide range of boosters? With sufficient standardization, military and civil launch authorities could accommodate such payloads as the ham community might generate, and we could ride aloft on a space-available basis. Thus was the CubeSat concept born.

Educational ham satellites are not new. Early examples emanated from university labs in Melbourne Australia, Surrey England, and Marburg Germany, as far back as the early 1970s. But the CubeSat concept meant that, for the first time, anyone could play. The actual package constraints were formalized a by Bob Twiggs, KE6QMD, and his students at Stanford University. Bob had previously taught at Weber State College in Utah, was the father of their small satellite program, and was the motive force behind the WeberSat WO-18 satellite. Building upon the Cuesta College concept, the Stanford team came up

with a standard cube, 10 cm on a side, 1 kg in mass, to which a whole generation of ham educational satellites was to conform.

By the time the cube was codified, Ed and Cliff had both retired from Cuesta College, and had moved across town to the California Polytechnic University, where they set up a satellite program to further refine the Stanford design. Recognizing that multiple pico-satellites could be accommodated by a single launch vehicle, they set about developing a common launcher interface, which doubled as an orbital insertion mechanism: P-POD, the Poly Picosat Orbital Deployer. This hollow rectangular frame, three CubeSats long, would mount to a variety of launchers with standardized hardware and a well-defined electrical connector. When triggered by a launch sequence command, its internal ejection spring would spit three peas from the pod, and into their individual orbits. Compatible with everything from Delta rockets to converted American and Russian ICBMs, the P-POD concept and CubeSat architecture together began to make satellites, and launching them, truly affordable.

Just how much technology can you cram into a one-liter cube the density of water? A surprising amount, it turns out. Once its mechanical specification was published on the Web, school groups around the world started building dozens of educational and scientific missions around the CubeSat standard. These small satellites, covered with solar cells charging lithium ion batteries, produced one to two watt power budgets in low Earth orbit, enough to power up a variety of experiments, as well as the 2 meter or 70 cm telemetry and telecommand links needed to support them. As this is being written (summer of 2006), ten CubeSats are currently operational, with fourteen awaiting an imminent launch, and over fifty more under construction around the world.

CubeSats are relatively cheap, both to build and to launch. The last dozen specimens averaged about \$100,000 US apiece, *including* launch costs. That may be a bit pricey for your pocket, or mine, but it's comfortably within the budget of many an educational institution.

CubeSats are quick turnaround. The typical project spans about two years, from concept

to completion. That's comfortably within the lifespan of the average graduate student. And, CubeSats are accessible, thanks to a high degree of standardization. They're not exactly Heathkitsats, at least not just yet, but we're getting there. Today, you can buy many of the necessary components, including standardized spaceframes and power system pieces and attitude control systems and datacomm links, all in kit form. These COTS (commercial, off-the-shelf) kits free up your students to concentrate on designing and implementing the mission-specific hardware and software that will make their picosat unique.

CubeSats typically operate in the ham bands. They are eligible for IARU frequency coordination, as long as their command stations are run by licensed radio amateurs, within the terms of their individual licenses. It's common for a ham faculty advisor or AMSAT mentor to start the ball rolling. Typically, before their satellite even launches, most of the students on a given CubeSat team will have gotten their licenses. So, the potential for recruiting new hams is substantial. And, these hams are pre-qualified, potential AMSAT members, who have already demonstrated a keen interest in satellite technology.

CubeSats end up being built and operated by hams. But, are they ham satellites? That depends on how broad a brush you use to paint the ham radio portrait. The primary mission of CubeSats is education. Their secondary mission is scientific. Remote sensing is a popular application. CubeSats monitor everything from seismic activity on Earth to micrometeorite impacts in space, using ham radio to relay their images or digital data streams back to Earth. So, if your notion of ham radio is restricted to ragchews and chasing DX, then no, a CubeSat is probably not a ham satellite.

I prefer to take a wider view. Just why should AMSAT, an organization devoted to ham satellites, support the CubeSat concept? Three reasons.

1. Many CubeSats are being designed with a built-in tertiary function, that of data relay. They can be telecommanded from the ground into digipeater mode. So, when they're not serving their primary

continued on next page ...



and secondary missions, you will be able to use them as ham store-and-forward birds, for everything from packet traffic to APRS position monitoring.

2. CubeSats have a life expectancy that typically exceeds their mission duration. Students eventually graduate, and move on to other things, but their satellites remain in orbit and fully operational. When the scientific instruments are turned off, the CubeSats are able to be repurposed into linear transponders or FM repeaters. Increasingly, CubeSat developers are addressing this eventuality early in the design cycle.
3. CubeSats are a training tool. Amateur Radio has an educational mission. The two are highly compatible. Today's students, building and operating small, lightweight, low-power, LEO CubeSats, are tomorrow's AMSAT members, designing, building, and operating the most sophisticated high-power, high-orbit amateur satellites you care to imagine. Work with them now, and they'll work with us later.

Are CubeSats OSCARs? Not all, but some. Those projects that jump through the right hoops (prior IARU frequency coordination, licensing by their respective countries, control stations properly licensed, and conforming to ham radio's usual restrictions on third party traffic and commercial use) can, if they achieve orbit and are heard in the ham bands, apply for an OSCAR number. True, these are experimental spacecraft. So were our early OSCARs; so, in fact, is every ham satellite to date. By encouraging CubeSat team leaders to apply for OSCAR numbers, we are sending them a powerful message: we hams welcome them into the fold.

How do you go about building a CubeSat? Start with a ten by ten by ten-centimeter cube, and fill it with a kilogram of electronics. Stuff it into a P-POD along with a couple of its cousins, and hitch a ride into low Earth orbit. Thousands of hams around the world, many of them AMSAT members, are already standing by to track your satellite, copy your telemetry, analyze your data, and stake their claim to one thousand cc science.

So, are CubeSats Amateur Radio? I, for one, vote in the affirmative. 📡

AO-51 Digipeater Notes

Using the AO-51 Digipeater

by Bob Bruninga, WB4APR

The AO-51 Digipeater operates on 145.86 uplink and 435.150 +/- Doppler downlink (9600 baud) but has some very unique characteristics that are different from normal digipeater expectations.

Since this is a 9600 baud digipeater only, the most probable users will be owners of the TH-D7 and TM-D700 APRS radios with built in 9600 baud APRS TNC's. What is different about the AO-51 digipeater compared to ARISS or the PCSAT's is:

- 1) The downlink is weak and you will need a beam to receive and you must tune Doppler
- 2) The uplink is easy to hit even with the 5 watt HT to an omni-directional antenna.
- 3) The digipeater is full duplex and the TNC in the D7/D700 is only half duplex. Thus the SENDER of a packet will usually NOT see his own packet digipeated unless he is using two radios.

Because of these unique features there are two primary user modes that can still be efficiently used on this space system:

- a) Two-way APRS message QSO's with stations using a decent downlink antennas
- b) Station uplinks of position, status, or messages or email into the global APRS system from remote locations for receipt and viewing on the Internet.

To make Item b work, requires several AO-51 9600 baud packet satellite gateways operating around the world and feeding their live downlink into the global APRS Internet system. The rest of this note will address how to uplink through this application.

Here is what the sender should do:

- 1) Use a UNIQUE callsign-SSID for this experiment so that the data is not overwritten when you then later operate terrestrially
- 2) Use the uplink path VIA PACB-1 at 9600 baud
- 3) Set your position rate to about once a minute during the pass.
- 4) Enter a CQ message into the radio with a TOCALL of ALL
- 5) Check http://map.findu.com/mycall* to see if you made it.

Anyone can be a SATGATE feeding into the global APRS Internet infrastructure simply by QSY'ing their normal APRS IGate from the APRS channel to 435.15 +/- Doppler and changing to 9600 baud on their TNC for the duration of a pass.

Although a beam is needed to bring in the weak signal for one SATgate, this system is unique in that the APRS Internet system combines the output of ALL SATgates and so only one station at a time really needs to hear each packet. Thus, if we had as many as 6 SATgates across the USA in the north and south, they would only need a SIMPLE 19" 3/4 wave vertical receive antenna (no moving parts) and they would not have to tune Doppler either, since they would only receive well for the few minutes the satellite is overhead.

Thus, these 435.15 fixed tuned and fixed OMNI SATgates could provide continuous coverage over the USA if there were enough of them.

If you have a spare 9600 baud TNC and UHF receiver to dedicate to this mission, it would really serve a great service. The 19" whip over a ground plane does have almost 8 dBi gain above 30 degrees and so it CAN hear the downlink in the middle of a high elevation pass.

Hope this helps. 📡



amsat.org

Exciting new look!
Great new features!
Easy to maneuver!

Try it, you'll love it !



Project OSCAR and Cal Poly Honor Cliff, K7RR

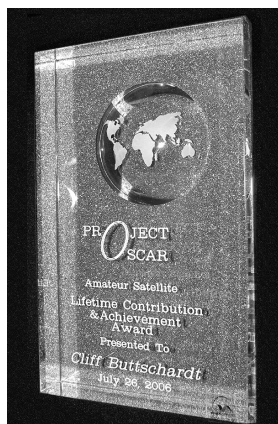
On July 26, 2006 the Project OSCAR Board of Directors awarded long time Project OSCAR and AMSAT member Clifford C. Buttschardt, K7RR, its highest award, the Lifetime Achievement Award for contributions to Amateur Satellite Radio. The award was presented at California Polytechnic State University (Cal Poly), where Cliff has been mentoring students for many years.

In her opening remarks Project OSCAR Vice-President Emily Clarke, N1DID, noted "In March of 2006 the Board of Project OSCAR voted to recognize Cliff with an award for his achievements and his lifetime of contributions to amateur satellite programs. Over the years Cliff contributed much to Project OSCAR, AMSAT and was one of the guiding forces behind the CubeSat program at Cal Poly, where he has been working quietly behind the scenes as an advisor."

Project OSCAR President Don Ferguson, KD6IRE, then read the award inscription, "This award is given to Cliff Buttschardt, K7RR, for his lifetime contribution to Project OSCAR, AMSAT, and amateur satellite radio."

Professor Jordi Puig-Suari, CubeSat Program Co-Director also acknowledged Cliff's contributions. "Cliff was a crucial part of the mentoring that the students received from the AMSAT community. We wouldn't be here without his help. The students and myself want to do something special for Cliff, and we are changing the name of the CP-1 satellite to K7RR-Sat in his honor."

Unfortunately Cliff could not be in attendance for health reasons, but after the event Don and Emily met with Cliff and his wife at their Morro Bay home where the Lifetime Contribution & Achievement Award was officially presented. 📷



Clifford C. Buttschardt, K7RR Silent Key

Cliff Buttschardt, K7RR (formerly W6HDO), became a silent key July 30, 2006 at 9:47 PM PDT. He was a lifetime member of both AMSAT and the ARRL, and an original member of Project OSCAR. Cliff was also a member of the Central Coast Astronomical Society and many local Amateur Radio associations, most recently the Estero Radio Club on the Central Coast of California where he served as club secretary. He died quietly in his home in Morro Bay after battling inoperable cancer of the esophagus for many months.

Cliff was born in 1931 in Brooklyn, NY and later lived in Garden City on Long Island. When he was 17 he decided that he had enough of NY and ran away from home. He got as far as Chicago before his car broke down, but his parents allowed him to continue to San Jose where he lived with a cousin. Cliff finished school in San Jose and went on to graduate from San Jose State with a degree in electrical engineering.

After graduation Cliff joined the Navy where he worked as a radioman. Upon leaving the Navy he returned to the Bay Area and went to work at Raytheon in Santa Barbara. Cliff went on to work at SRI International in Palo Alto and began teaching part time at Foothill College. While at SRI he became a member of the original Project OSCAR Radio Club and supported the construction of the first amateur satellite, OSCAR-I. Cliff and other members of the Palo Alto Amateur Radio Association (PAARA) designed, built and kitted one of the first AM/FM 2M transceiver kits.

In 1975 Cliff left SRI to pursue a full-time career in teaching. He joined the faculty at Chico State University (where he also became a rancher growing almonds and oranges.) Not one to let the grass grow under his feet, Cliff left Chico State in the early 1980s and founded a marine electronics company in Morro Bay. He continued to teach at nearby California Polytechnic State University and Cuesta College in San Luis Obispo where he became good friends with Ed English, W6WYQ.

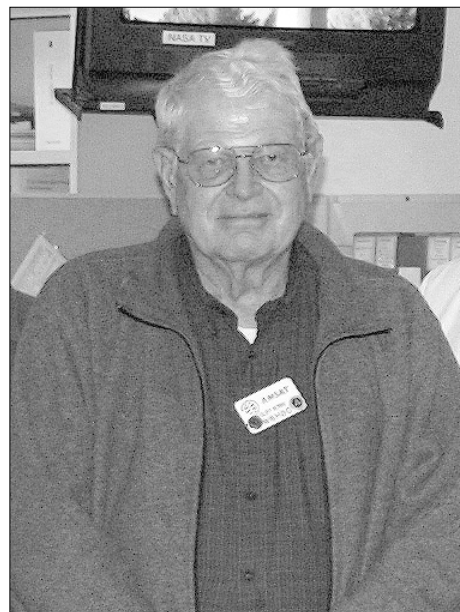
In 1989 and once again in search of adventure, Cliff left his teaching job at Cuesta College and returned to the sea, fulfilling a lifelong dream to work as a radio officer in the Merchant Marine. While at a stopover in Naples, Italy in 1990 his ship

was federalized when Iraq invaded the State of Kuwait, and Cliff found himself back in the Navy once again. Although well past the time for mandatory service, Cliff remained in the Navy and served through 1991 during the first Gulf War and remained at sea until 1995.

Cliff returned to Morro Bay where once again taught at Cuesta College where in 2001 with Ed English, W6WYQ, they began work on the CubeSat project. Cliff then moved over to California Polytechnic State University (Cal Poly) where he and Ed continued to mentor students who were just starting up the initial CubeSat designs. In 2002 Cliff and Dr. Clark Turner, WA3JPG, made the first proposal to AMSAT for the use of amateur frequencies for the CubeSat program.

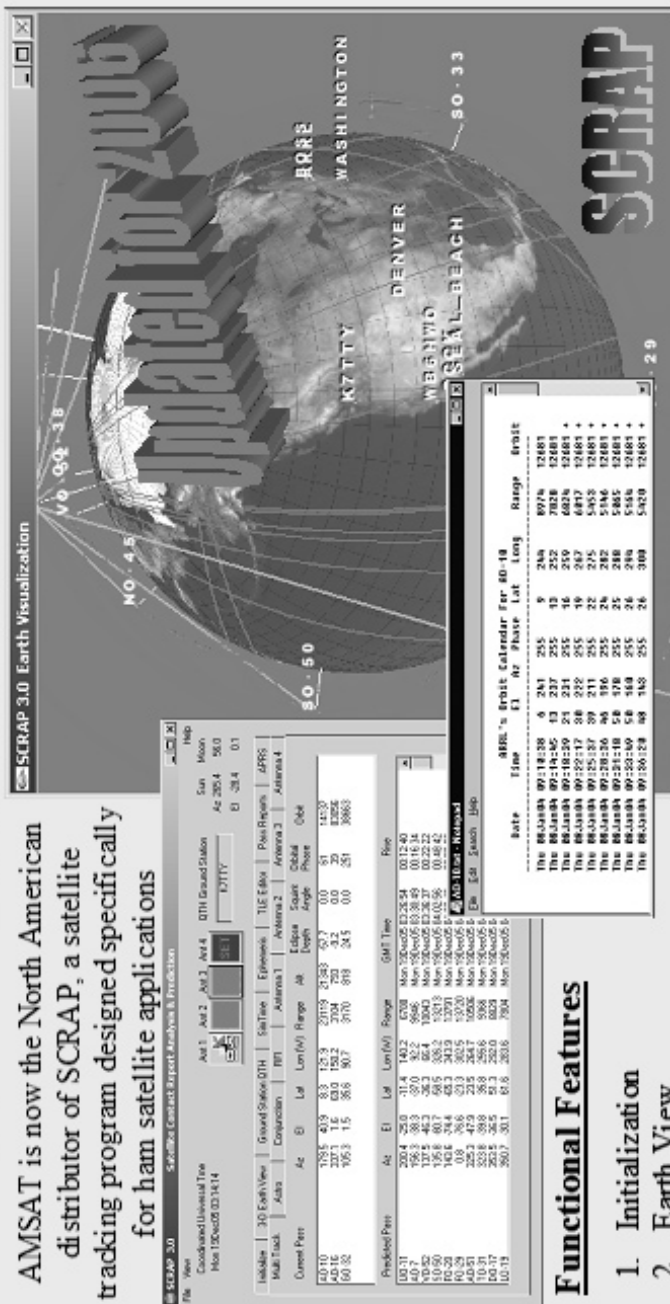
In March of 2006 the Project OSCAR Board of Directors voted unanimously to award Cliff its highest honor, the Lifetime Achievement Award, for his contributions to amateur satellites, Amateur Radio and the CubeSat program. Over his lifetime Cliff supported many of the amateur satellites that were launched from Vandenberg AFB. The award was presented during the CubeSat Launch Party at Cal Poly on 26 July 2006, and to Cliff personally at his home on the same day.

Cliff is survived by his wife Mabs, who was with Cliff when he passed on. It is requested that in lieu of flowers a contribution to AMSAT be made in Cliff's name. 📷



Satellite Contact Report Analysis Prediction 3.0

AMSAT is now the North American distributor of SCRAP, a satellite tracking program designed specifically for ham satellite applications



Functional Features

1. Initialization
2. Earth View
3. Ground Station QTH
4. Date/Time Simulation
5. Ephemeris
6. TLE Viewer & Editor
7. Pass Reports
8. APRS display
9. Multi-Track display
10. Four Ant rotor controllers
11. Astronomical prediction
12. Satellite Conjunctions
13. Radio Frequency Interference

Recommend minimum processor

1. Windows 98 or better
2. Pentium Processor 500 MHz or greater
3. 256 MBytes RAM
4. Graphics accelerator card desired
5. 1024 x 767 resolution recommended

SCRAP is a product of the
Bytheway Software Development Lab (BSDI)
More info at <http://www.rtty.com/bytheway>

Performance Features

1. Contact Prediction / Reports
2. SGP/SDP ephemeris prediction
3. Real-time 3-D visualization
 - a. City, country, satellite labels
 - b. Lakes, rivers, islands
 - c. National boundaries
4. Over 25 Earth texture overlays
5. APRS station display
6. Multiple ground station support
7. Antenna rotor Az/EI control
8. Internet updates
 - a. Two line orbital elements
 - b. APRS station locations
9. Astronomical data (Planets, moon)
10. Simulation

Order your copy now

Price is \$50 for AMSAT members,
\$60 for non-members, postpaid on
CD-ROM. Order by calling 1-888-
322-6728, or use the online shop at
<http://www.amsat.org>

AMSAT Eagle Update

James A. Sanford, PE, WB4GCS, wb4gcs@amsat.org, Eagle Project Manager

Our Vision is to deploy high earth orbit satellite systems that offer daily coverage by 2009 and continuous coverage by 2012...



Profound developments are taking place with the Eagle design. We continue to progress from concept definition to concept refinement and detailed design.

A meeting was held in San Diego on 29 and 30 June at Qualcomm – Franklin Antonio, N6NKF, and Phil Karn, KA9Q, were our hosts. The purpose of the meeting was to hammer out details of Eagle's digital payload. We achieved the objectives, and the results impact the entire Eagle mission.

Bob McGwier, N4HY, opened the meeting and then AMSAT President Rick Hambly, W2GPS, briefed the high level objectives of AMSAT, the Eagle project and his expectations for this meeting. Next, I presented an overview of Eagle's current Functional Requirements Document (FRD). This sparked an animated discussion, with Franklin, N6NKF, asking many pointed questions. In that conversation, I reiterated our desire to provide some hand-held capability for quick and easy emergency communications and a strong desire for Eagle to serve users restricted by living in an apartment or restrictive covenants and restrictions (CC&Rs). Tom Clark, K3IO, led a discussion of our satellite microwave bands and the constraints and concerns associated with each. Matt Ettus, N2MJI, led several discussions of GNU radio history and objectives, his Universal Software Radio Peripheral (USRP) and some proposals for Eagle's digital payload.

This set the stage for some really intense discussions of services to be provided and the dueling link budget spreadsheets running in various corners of the room. We defined four classes of user:

- Class 0: Traditional linear transponder users, SSB, CW, etc.
- Class 1: Low data rate text to and from hand-held ground stations
- Class 2A: Digital voice to ground station with coarsely steered and electronically aimed patch array
- Class 2B: Digital voice to ground station with steerable 60cm dish
- Class 3: Digital video to ground station with 1.8m steerable dish

At the end of the first day, we had reached some conclusions:

1. Hand-held digital voice is not supportable by a spacecraft we can fly (size, power).
2. Hand-held text messaging is possible and only practical on the U/V band.
3. S-band (2.4 GHz) is unusable as a weak signal or digital downlink over much of the earth due to elevated noise floor from Part 15 devices such as 802.11 networks.
4. S-band (2.4 GHz) is probably usable as an uplink.
5. The electronically aimed patch array at the ground station was just not good enough, largely due to terrestrial noise picked up in the side lobes.
6. A 60cm steerable dish on the ground will be required to work the digital modes. AMSAT will have to develop an affordable steering system as part of the system design. This consideration has an effect on our desired orbit.

The various link budget spreadsheets being run simultaneously served as a real-time peer review and rigorously supported the conclusions. Our final spreadsheet is available on EaglePedia as a .pdf file; this serves as a record of what we accomplished. The .xls spreadsheet is also available for those who wish to download and do their own analyses.

The news about 2.4 GHz was particularly disappointing to many. The harsh reality is that the noise floor has been measured by Jan King, W3GEY/VK4GEY, and Kerry Banke, N6IZW, to be 20 to 30 db higher than "thermal" noise in several areas, including at least one location well removed from nearby houses, etc. These reports were amplified by anecdotal evidence from nearly all attendees. To put this in perspective:

- My Drake downconverter for AO-40 had a noise figure of several db and could barely hear AO-40 with a 3 foot dish. When I put a 1db NF preamp at the dish, I could comfortably hear AO-40, but it was never loud.
- Now imagine a 17db worse NF. I'd never hear the bird.

We had a protracted discussion about ways to mitigate the QRM or drive it away from our downlink band but the brutal reality is that the noise floor has been raised to the point that, in many areas, S-band is no longer usable. The equipment you used to hear AO-40 several years ago would not hear a signal we can possibly generate in Eagle five years from now. The prognosis is that the noise level will only get worse. So, disappointing or not, it is clear that 2.4 GHz as a weak signal downlink is history.

Tom Clark did some quick calculations, like he did for C-band, to evaluate the effect of this noise at the satellite. The noise is higher than at C-band due to lower path loss and concentration of all the noise sources in 50 MHz rather than 550 MHz, but we concluded that we could readily generate enough power in an affordable ground station to overcome this. These estimates will be refined in the near future and published on EaglePedia.

We also delved into the details of which bands to use for uplink and for downlink, modulation schemes and the details of how to allow multiple users. For RF bands, we considered, L (1.2 GHz), S1 (2.4 GHz), S2 (3.4 GHz) and C (5.8 GHz). After consideration of the pluses and minuses of each band for uplink and downlink, we concluded that S1 up and C down is the best way to go. We considered, and will continue to explore, S2 as an uplink or downlink, but that band is not currently available world-wide.

Preliminary decisions were made on modulation schemes and multi-user access protocols. Now the real work begins, designing signals, bit-streams, and protocols.

We spent quite a bit of time on details of the phased array antennas and how to implement them. The most important conclusion is that electronically steering the beam from the spacecraft with the phased array antennas will allow use of the microwave payloads over 75% of the orbit. Historically, amateur satellite microwave payloads have only been usable near apogee, so this is a huge improvement in service to the user community.





One of the last discussions led to a preliminary power budget, which concluded that Eagle will need a maximum of 300 watts of power generation. At 300 watts maximum, we expect to be able to run most or all of our amateur payloads regardless of sun angle and our TSFR packages during times of optimum solar irradiation. This Space For Rent, or TSFR, packages are science projects we hope to fly in exchange for services from those who might be able to help Eagle fly.

The power and antenna real estate requirements led to another brutal conclusion: The Eagle spacecraft we've been visualizing for many years will not meet the mission requirements. So, that design has been archived for possible future use and we're off pursuing one that will meet our requirements. Figure 1 shows one possibility, which is being considered. Note that it retains the feature of angled solar arrays to maximize power generation at any solar angle.

Refining, designing, and modeling a structure are just a few of the action items going forward from this meeting. We need to define the digital signals, design, model and prototype the phased array antennas, and pursue the regulatory issues associated with the S2 band.

We've reached a major milestone in the Eagle design process. We reconciled goals with the fundamental laws of physics and reached conclusions on what is possible and

what is not. Actions moving forward have been defined and responsibilities assigned. Some major changes have been necessary, but we knew all along that this was a distinct possibility.

All of this discussion and the conclusions are discussed in much more detail in the meeting report, which is available on EaglePedia, at: http://www.amsat.org/amsat-new/eagle/EaglePedia/index.php/San_Diego_Digital_Meeting

If this is not available to you when you read this, try again in a few days – we're making sure the text is perfect.

There has been other work in support of the Eagle mission. There has been an ongoing discussion over various orbit parameters, consequences, and implementation. For example, if Eagle is in basically an equatorial orbit, ground segment antenna aiming gets much simpler – directly supporting our goal of an affordable ground segment with simple, affordable, pointing equipment.

In a particularly exciting development, Marc Franco, N2UO, and his student, Steve Hendrickson, developed and demonstrated a 5W, 2.4 GHz amplifier with 61% efficiency. This effort received Honorable Mention in a recent IEEE competition among efficient microwave amplifiers in the 5-watt class. AMSAT VP Engineering, Bob McGwier, N4HY, assisted in this effort. Marc writes that his team has a goal of an amplifier with

80% efficiency. Historically, our amplifiers have had 15 to 20% efficiency. This kind of efficiency means we'll have a much louder downlink signal, even if it winds up on a band other than 2.4 GHz. Take a close look at Marc's article elsewhere in this issue of the Journal.

Finally, your AMSAT and Eagle leadership has been busy "talking up" AMSAT and Eagle. As I write this, I'm on the road in about four hours for a presentation at the Maryland state ARRL convention. Rick Hambly, W2GPS, is in Surrey for a similar presentation to the AMSAT-UK Colloquium. Bob McGwier and Tom Clark, K3IO, are in Minnesota making similar presentations at the Central States VHF Society conference. We're all talking about what AMSAT is doing with Eagle, and trolling for additional support.

Speaking of conferences, I hope to see you at the AMSAT Symposium in San Francisco this October.

As always, comments and questions to: wb4gcs@amsat.org

73,

Jim 

Figure 1: AMSAT Eagle.

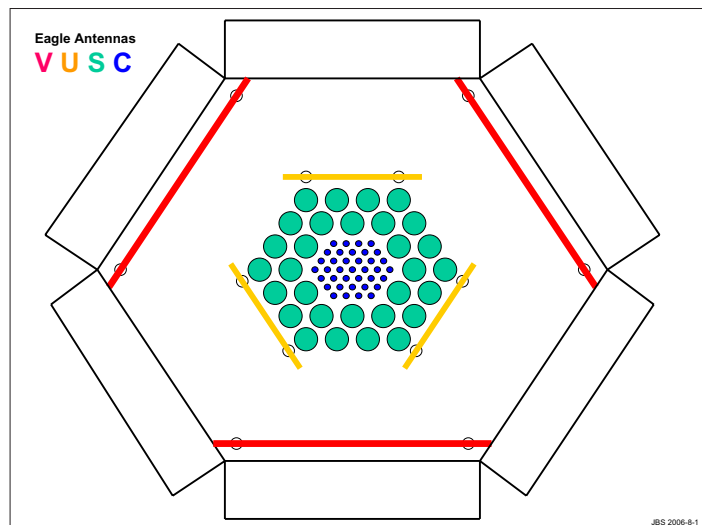
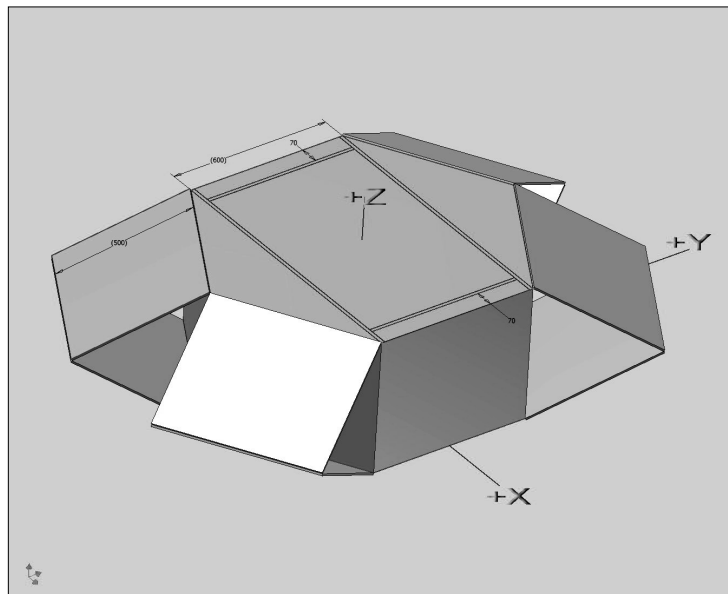


Figure 2: A possible Eagle antenna arrangement.



Recipe for a Field Day Satellite Station Failure -- And How to Recover (2005)

by Jim Sanford, WB4GCS, wb4gcs@amsat.org

Ingredients

IC-910 with manual, microphone and CW key
2 Rohn 25 tower sections
ONE (of three available) top sections with alignment key forcing rotor installation in one particular position
Guy wire
Stakes and mallet
G-5400 rotor and easy track controller
Rotor cables
Coax
V-band, U-band, L-band and S-band CP antennas
Cross boom
S-band down converter and spare, with antenna
Preamps for V, U and L-band
Laptop with Nova and logging software
IC-736 with microphone
Magnetic compass
Tower tools, bolts and parts
Brain salad surgery (radio) tools
Cooler with soda and adult malted beverages of choice

Procedure

Return from travel Thursday before Field Day.
After work on Friday, assemble all ingredients, except guy wire.
Saturday, deliver ingredients to Field Day site.
Set up radios, laptop rotor controller.
Instruct team on tower assembly. Commence assembly of tower.
Instruct team on antenna assembly. Begin.
Instruct team on preamp assembly.
Instruct team on 6M and 10M antenna assembly and connection.
Begin.
Connect radios, computer, and rotor controller.
RECOGNIZE ABSENCE OF GUY WIRES.
Instruct team on continuation.
Run home just under supersonic. No speeding tickets. (Honest!)
Collect guy wires.
Return to Field Day site.
Inspect completed assembly of everything.
Roll out and connect guy wires.
Walk tower up.
Realize antennas are nowhere near north.
Consider rotating rotor base – no way, bolt in anyway.
With magnetic compass, verify that antennas are “nearly” South.
Tell Nova the rotor is a SOUTH center.
Begin Field Day.
Between passes, make terrestrial contacts on VHF/UHF
Realize that “something just isn’t right.”
Make a few satellite contacts with difficulty.
Attempt to hammer tower base a “few” degrees to correct calibration.
Give it up.
Saturday night, think about correction instead of sleeping.
Sunday morning tell Nova to track the sun.
Confirm 20 degrees off.
Tell Nova to track the moon.
Confirm 20 degrees off.

Climb tower with come-along and a pole to push up the center, lifting rotor above obstruction.
Realize pole is too short and come-along too long.
Give up on major objective for this year of auto tracking.
Scrawl new meter scales and post on rotor controller.
Confirm S-band downconverter is on vacation.
Make contacts with manual tracking.
Make AO-51 S-band contact with hand-held backup converter.

Honest, it was that screwed up! BUT, we had fun, and recorded a lot of lessons for next year. Including, after an apprehensive tower lowering (which went very smoothly despite anxiety), “Maybe we should get a tilt-over crank-up tower on a trailer.” And, in view of all the public/emergency service work we do, we are actively pursuing this objective.

See you all on the birds next year - from N3SH! 📶



N3HKQ hearing AO-51.



National Fund Raising Project Status Report

Gunther Meisse, W8GSM. w8gsm@amsat.org

AMSAT Treasurer

National fundraising has been a challenge facing AMSAT for many years and with the significant monetary needs facing us we felt it was time to determine if we could successfully implement such a North American campaign. The scope of our needs include the development, construction and launch of the three HEO satellites the board voted to assist with and deploy by 2012, and the educational efforts we wish to further develop including high school space curriculums and additional university mentoring of up and coming young space engineers. The costs of this vision can easily reach between six and ten million dollars. Launch opportunities being the largest single expense for satellite deployment and outside professional assistance for a number of our educational objectives could easily reach hundreds of thousands.

At the 2005 annual Board of Directors meeting the board authorized the start of a national fundraising effort with the goal of raising substantial funding to support these projects. The process started immediately with the creation of a complete "Case for Support" written by Gunther Meisse, AMSAT Treasurer, which in combination with our recent AMSAT Annual Reports, and Membership Opinion Study, was used to enlist the services of Goettler Associates in Columbus, Ohio as our professional fund raising consultant. Goettler Associates has been active across the United States in the philanthropic field for decades and have an outstanding record of success. Members of the board including Rick Hambly, Gunther Meisse, Barry Baines & Tom Clark met in Columbus, Ohio with John & Ralph Goettler to outline our goals and define the nature of the assignment. Following that meeting and at the suggestion of John Goettler, we formed an ad-hoc campaign study committee comprised of President Rick Hambly, Treasurer Gunther Meisse, Vice-President Barry Baines, Vice-President Frank Bauer, Vice-President Bob McGwier, Director Tom Clark, AMSAT members and long time supporters Mal Preston and Terry Wittenburg. The committee's responsibility is to oversee the activities of Goettler Associates and serve as advisors during the feasibility study process. The Ad-hoc committee met during the Dayton

Hamvention and developed a list of those individuals that would be interviewed over the next few months by Goettler Associates. As of this writing in August, interviews have started.

The process for such a national fund drive starts with the development of a North American feasibility study. This study is comprised of confidential interviews with about thirty AMSAT leaders & members as well as individuals outside of AMSAT who have an interest in our program of work. The intent of the interview is to seek their confidential opinions regarding the program of work of AMSAT and their opinion regarding the likelihood for success of such a drive as well as providing advice on the selection of an attainable financial goal. Additionally, these interviews assist Goettler Associates and the AMSAT board in finalizing the financial goal for the drive and provide a road map for the actual campaign if the study suggests a substantial likelihood for success. Initial committee opinion suggests a goal of between ten and fifteen million dollars which would be managed by the AMSAT Endowment Committee, formed in 2004 and the AMSAT Board of Directors. The Feasibility Study will tell us whether this goal is realistic and if we should adjust the goal and in fact commence the actual drive or if we have additional issues which need to be addressed prior to any such endeavor.

It is our hope that Goettler Associates will be able to complete the interviews by the end of the year and that the Committee and the Board can then review these findings and plan a strategy for 2007 and beyond. When the Feasibility Study is complete and the Board has had an opportunity to digest the outcome, we will bring the membership up to date on the results.

This project is a major challenge for AMSAT and will need the support and enthusiasm of every AMSAT member and many of our friends in the space and technology community. The Vision is clear and now it is up to us to make it a reality. 🌐

Notes:



High Performance Software Defined Radio (HPSDR)

Dr. Bob McGwier, N4HY, n4hy@amsat.org

VP Engineering AMSAT

Ancient History

In 1986, with Tom Clark, K3IO, purchase of DSP boards from a garage operation known as Delanco-Spry was accomplished and we began to proselytize the virtues of DSP: "It's Only Software" was bandied about everywhere. We wrote many modems done entirely in DSP software. By the middle of 1987 we had convinced enough people in AMSAT and TAPR that Amateur Radio needed to take digital signal processing seriously and that it was going to have a major impact on Amateur Radio. TAPR and AMSAT joined together in a project called the TAPR/AMSAT DSP project.

Brooks Van Pelt, KB2CST, (L.L. Grace and Kansas City Tracker) and Pat Spadafore, KA2MOV, approached me about doing a DSP design because AMSAT was distracted (along with most of TAPR!) with the Microsat Project. We eventually produced a design and licensed it to AEA as the DSP-2232. It was a personal failure but an intellectual success and taught me many valuable life lessons. For the Microsat and the DSP work, including the DSP-2232, I was awarded the Dayton Hamvention Technical Achievement award in 1990. Microsat's were launched. Tom and I approached AEA about doing a completely software DSP

but if all the participants were honest, they would say that it was not the success they had hoped for.

Modern History

By the fall of 2002, Frank Brickle, AB2KT, had renewed my interest in Amateur Radio with all sorts of interesting things he was doing with QRP and I had begun contesting again. He had recently retired from the place we both worked and as he departed, he told me he went from zero to Extra in a single sitting! He pointed out an interesting article in QEX written by Gerald Youngblood, AC5OG, on "Software Defined Radio for the Masses". Four issues later Gerald announced the formation of Flex Radio and the availability of the SDR-1000. He and Brickle jointly resuscitated my interest in Amateur Radio technical work. Frank and I offered to lead the development of a software defined radio core and the project grew so fast it made our heads spin.

Gerald struggled for a year but working with me and several other amateurs, he discovered how to modify the front end of his radio to make it bullet proof. The ARRL did a review and the radio revealed the best dynamic measurements of any receiver ever measured in the ARRL labs in two tone tests administered at 2 kHz spacing. Gerald changed his callsign to K5SDR and Flex became a fully commercial company with a future.

Experimenters Control Their Destiny

As Gerald shifted focus from the experiments to build a radio company, the experimenters, as always, went looking for that next frontier. Phil Covington, N8VB, and Lyle Johnson, KK7P with a lot of help from Eric Ellison, AA4SW, led the experimenters who had gathered under the Flex Radio tent to form another project, one that was strictly noncommercial and doing nothing but "skunk works" and "best effort" irrespective of its commercial potential. They wanted completely open software and open hardware and to get very high performance in several different areas for the radios produced with the goal of minimization of price. Don Jackson, AE5K, hosted a Web site and called it HPSDR (High Performance Software Defined Radio). It has attracted many of the best and brightest in and out of



Figure 1: DSP-2232.

In the fall of 1987 at the AMSAT annual meeting, our focus was shifted when Tom and I joined Phil Karn and Jan King for a very late night session (which was normal back in those days) and we did a paper design of a microsatellite. We did the designs right down to the uplink and downlink. The next two years were a head spinning time as Tom and I and many others fell head first into Microsat (see Harold Price's, NK6K, comprehensive list of the participants at:

<http://www.amsat.org/amsat/sats/nk6k/msatname.html>) We, as a group, put DSP aside.

radio in 1989. They were interested. This was over a year before Joe Mitola coined the term Software Defined Radio. One of the principals in AEA contracted a serious illness and died. AEA went into decline and all of this was forgotten. I left Amateur Radio for professional work and family life and TAPR was left to do the DSP project by itself without much help from AMSAT. In 1993, several TAPR investigators lead the project to a conclusion with the DSP-93 and the TAPR/AMSAT project had its first real product.

Further work was done with the EVM modules using the Motorola DSP56001





Figure 2: DSP-93.

Amateur Radio from all over the world. Such luminaries as Ulrich Rohde, N1UL, have joined. It was clear to many of us that all of that failed potential in the early DSP projects was going to return with a vengeance by the idealistic approach taken by this group from the first days. Using the DttSP core Frank and I have done for the Flex SDR-1000 and GnuRadio SDR toolbox code (<http://www.gnu.org/software/gnuradio/>), HPSDR has huge potential in many different areas. It is one of the most exciting new projects I have had the pleasure of being in early on and TAPR has decided to sponsor HPSDR.

What does this have to do with us? AMSAT is attempting to design the Eagle spacecraft. It is undergoing major revisions at this time but one thing is clear; it will be

completely dominated by software defined radios. Tom Clark coined SDX for software defined transponder and Matt Ettus, N2MJI, (<http://ettus.com>), designer of the USRP (another software radio interface), started us down the road towards a digital transponder at a meeting in San Diego in June. Lyle Johnson and I have come up with an SDX design for our linear transponders and it will be on P3E and Eagle. Lyle is doing the entire detailed hardware design work and circuit board layout for this. We are going to need significant development in SDR hardware and software technology for our linear transponder and the digital transponders we are designing for Eagle. Several of the projects will have a direct impact on both the spacecraft and ground station design for Eagle. Rick Hambly, president of AMSAT, has taken on the design of a major subsystem in HPSDR and recently announced that AMSAT will join with TAPR again to support this project. Rest assured, this time, we will keep our focus. We truly believe that many of you have purchased your very last conventional radio and AMSAT is helping to lead the way. ☺

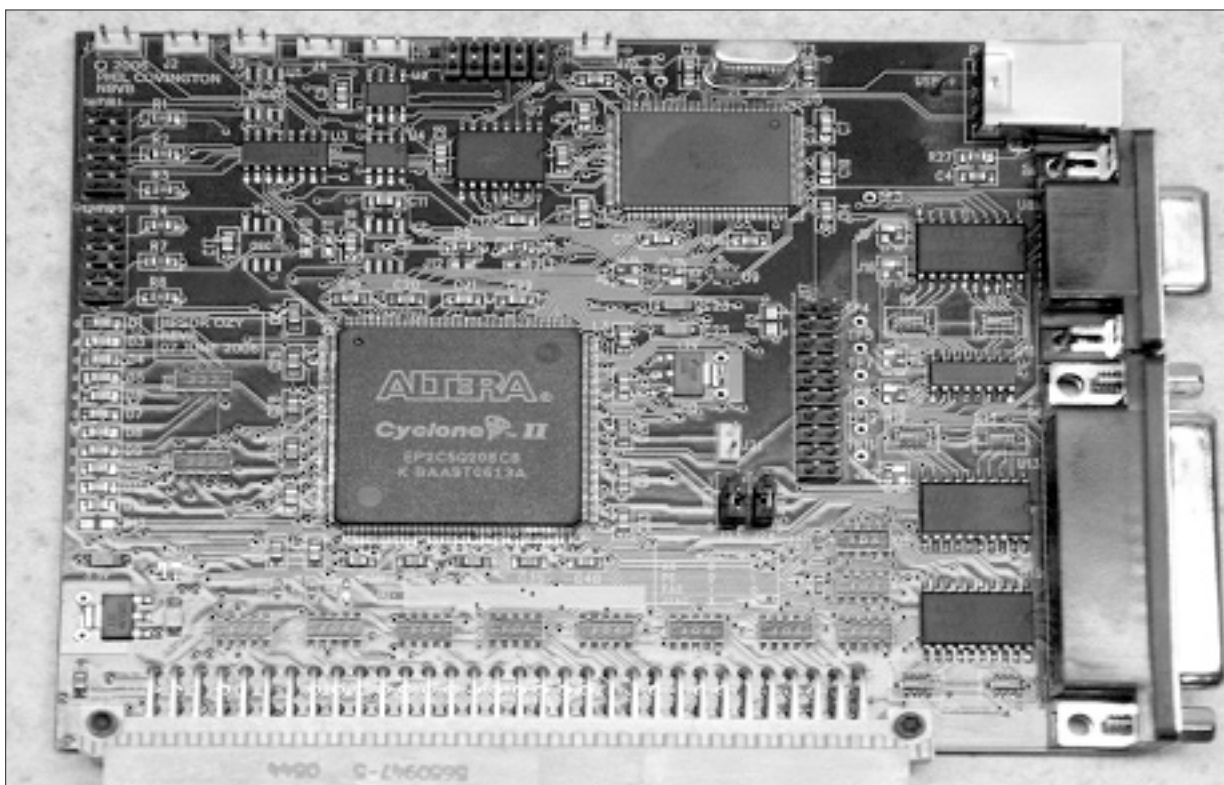


Figure 3: HPSDR's main board, OZYMANDIAS.



Build this Cheap and Easy Satellite Downlink Antenna

by Richard F. Crow, N2SPI, n2spi@amsat.org

Author's Note: You've never seen an antenna constructed like this. You've never seen an antenna presented like this either. What follows is a revised copy of a free handout I developed for the AMSAT booth at the 2006 Rochester (NY) hamfest. It is intended to enable non-satellite hams to painlessly acquire the 440 MHz downlink antenna needed to actually hear and work a satellite. I also had companion handouts for my designs of easy-to-build 2m uplink antennas. These handouts will be published later. For more background on how these handouts got started, see my article in the May/June 2005 issue of *The AMSAT Journal* titled "AMSAT at the Rochester Hamfest". Feel free to copy this handout and give it away at your next AMSAT presentation or

hamfest. Also, it makes an excellent school, club or Boy Scout project.

Virtually no ham antenna article today lists all the materials, tools and specific building instructions so that a beginner can build it. As a result, only a well-equipped, skilled and experienced ham can hope to replicate those designs. In addition, many hams today don't have a machine shop or even a basement workshop or even power tools. So, after the 2005 Rochester hamfest, I put many months of thought into the design and presentation of an inexpensive, build-it-yourself satellite antenna which would remedy these issues. What emerged is presented here.

Introduction

Typical transmit power for an FM LEO

(Low Earth Orbit) satellite is only 250 to 500 milliwatts. With satellite to earth station distances of 400 to 2000 miles, receiving these kinds of signals adequately requires a gain antenna. So, I downlink the FM LEOs (AO-27, SO-50 and AO-51) with a homemade, handheld 440 MHz Yagi antenna. The electrical design for this antenna is from Cheap Yagi Antennas for VHF/UHF by Kent Britain, WA5VJB, (Google Cheap Yagi). I re-engineered the mechanical design to be super lightweight and super easy to build. I did this by inventing a foam board boom laminated with double-sided tape, aluminum wire antenna elements and no solder coax connections. Only a few simple hand tools are required. No power tools are required. And, I list all the tools and materials needed

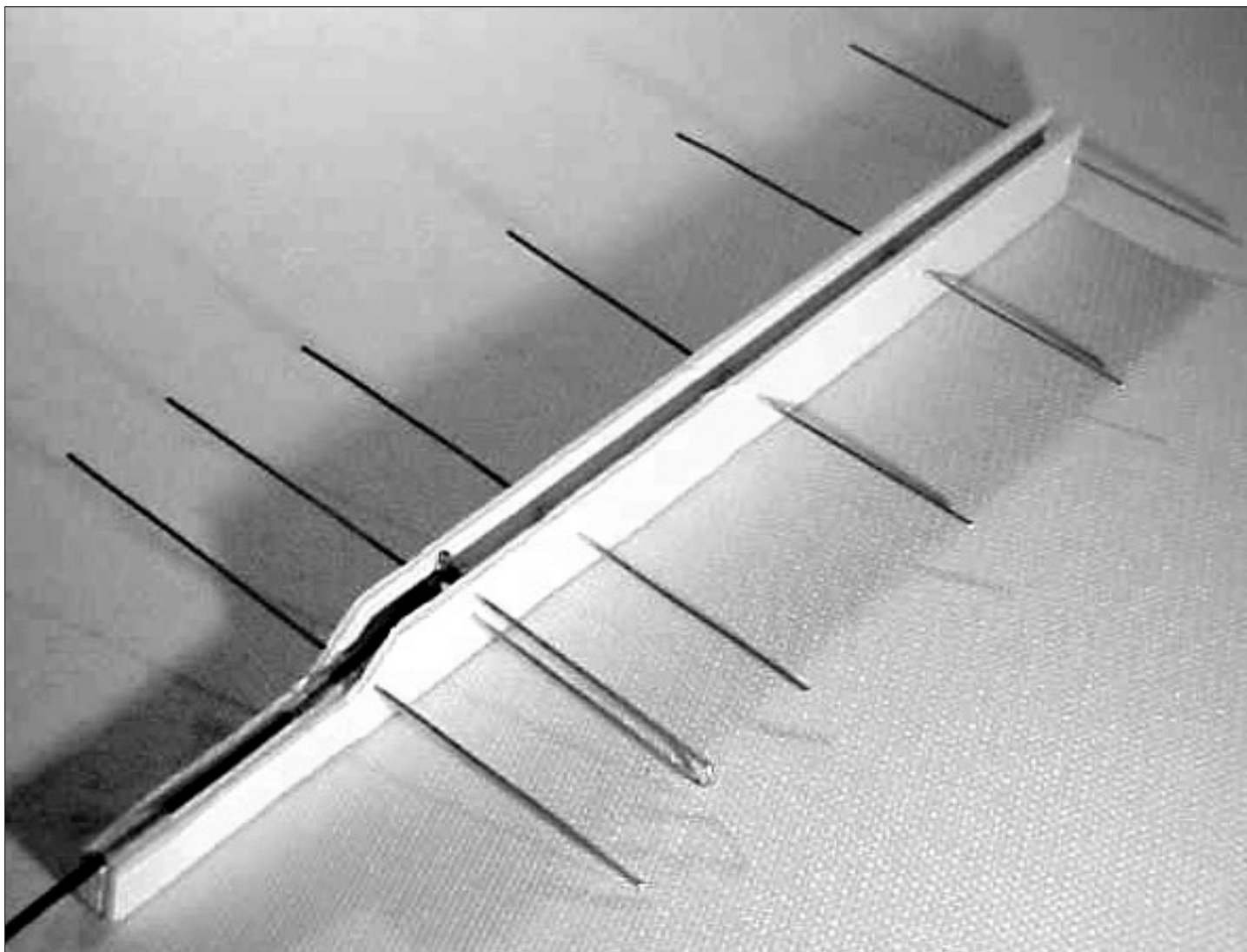


Figure 1: The N2SPI Cheap and Easy Satellite Downlink Antenna.

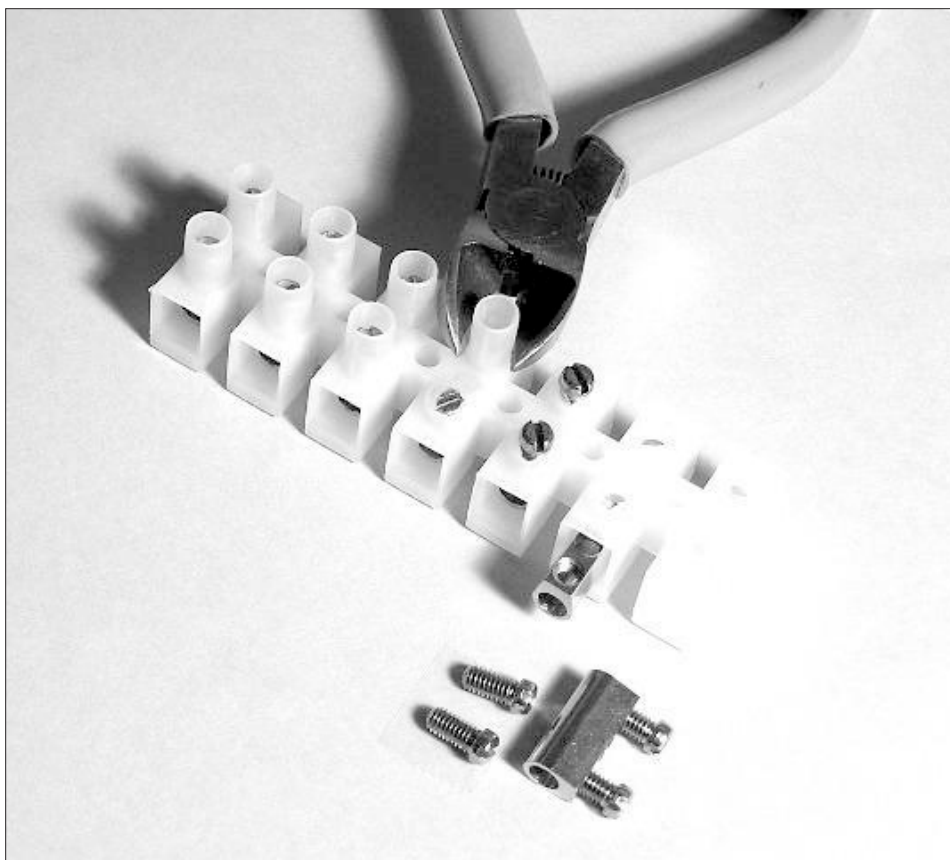


Figure 2: Terminal strip in various stages of disassembly.

and give detailed step-by-step instructions so that anyone can build this antenna. And finally, not only does this antenna receive the satellite signal from horizon to horizon; it's also light as a feather making it very easy to hold. See Figure 1.

Step-by-Step Instructions

- 1) Read these instructions all the way through to get an idea of what's involved. Pay particular attention to how tools are used in case you don't have one and can make a substitution with a tool you have.
- 2) Referring to the list of materials in Table 1, acquire the necessary materials if you don't have some of them already.
- 3) Referring to the List of Tools in Table 2, make sure you have the necessary tools or suitable substitutes. If you aren't familiar with a particular tool look it up at www.sears.com or other tool supplier Web sites. The Sears tools shown are excellent but pricey. You may find less expensive equivalent tools at Home Depot, Wal-Mart, etc.

In the next three steps, liberate two wire-to-wire connectors from the Euro-style terminal strip. The wire-to-wire connector is the

secret to the "N2SPI No-Solder Connection Method".

- 4) Select a terminal on the Euro-style terminal strip and, using the flat 1/8" blade screwdriver, screw both screws in the terminal all the way in. Now, use the diagonal cutters to clip off the tops of both plastic screw towers just above the screw heads.
- 5) Unscrew both screws until they fall out. Now, push the terminal's metal barrel out of the plastic housing.
- 6) Now, re-install both screws into the barrel to complete the first wire-to-wire connector, hereafter called a connector. Repeat Steps 4 through 6 to obtain a second connector. See Figure 2.

In the next four steps, make two 2-1/4 inch by 30 inch foam board strips for the side panels on the antenna boom.

- 7) Position the foam board so a 30 inch factory edge, hereafter called a factory edge, faces you. Place the two pine boards under the foam board so it is elevated and lies flat and steady. Adjust the combination square so 2-1/4 inches of the rule (metal ruler part) is sticking out of the attached head. Then, place the

head of the combination square against the factory edge and with the rule lying flat against the foam board, make two pencil marks, one at 2-1/4 inches up the left side, and one 2-1/4 inches up the right side, from the factory edge. Use the straight edge to draw a 30 inch line between the two marks. This general measuring procedure is hereafter called "using previous measuring methods".

- 8) Now, place the first pine board under the line on the foam board so as to act as a cutting board. Place the second pine board so the foam board lies flat and steady.
- 9) Be sure the X-Acto knife has a fresh, sharp blade. Now, carefully and patiently (take your time), trace along the line with the tip of the X-Acto knife. At first, just penetrate the surface paper. Repeat, cutting a little deeper each time, and as you can, gently bend back the foam board to expose the cut. Finally, cut through to make a foam board strip (hereafter called a strip). Write "bottom" on the factory edge to make it the bottom edge. This general cutting procedure is hereafter called "using previous cutting methods".
- 10) Repeat steps 7 through 9 to make a second 2-1/4 inch by 30 inch strip which includes the other factory edge. These two particular strips are hereafter called "side panels".

In the next step, make three 1-1/4 inch by 30 inch foam board strips for the inner core of the antenna boom.

- 11) Using previous measuring and cutting methods make three 1-1/4 inch by 30 inch strips. Note: (1) there are no more factory edges to locate, and (2) after each strip is cut, write "bottom" on its better, 30 inch edge to make it the bottom edge.

In the next three steps, laminate the three 1-1/4 inch wide by 30 inch long strips to make the inner core of the boom.

- 12) From one end of a 1-1/4 inch by 30 inch strip, lay down a first piece of double-side tape near the top edge for the first 15 inches. Then cut neatly with the X-Acto knife. In a similar way, lay down the remaining 15 inches of double-sided tape. Using the same procedure lay down a two pieces of double-side tape near the bottom edge.



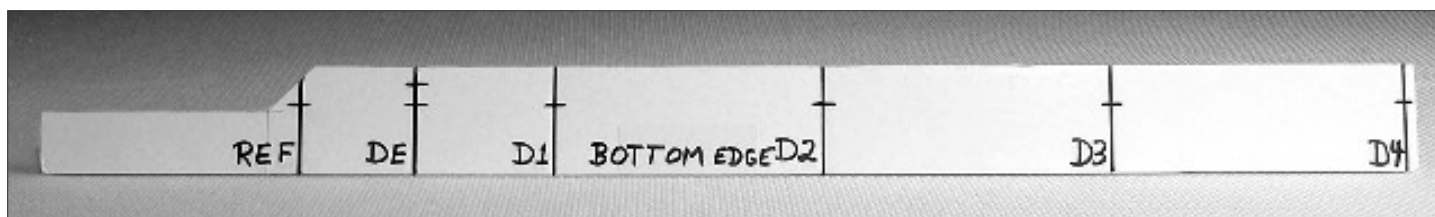


Figure 3: Side panel with element positions marked (markings made very dark for illustrative purposes).

13) Take a second 1-1/4 inch by 30 inch strip, line up the bottom edges and one end of the two strips. Starting at the one end, progressively press the second strip onto the first, keeping the bottom edges lined-up until you're done. If the strips are slightly warped combine the warp of one strip with an opposite warp from the other strip, so they cancel out.

14) Repeat Steps 12 and 13, hereafter called "using previous laminating methods", to laminate the third 1-1/4 inch by 30 inch strip together with the first two.

In the next five steps, cut a handle out of one end of each side panel.

15) Using previous measuring methods, from the bottom left corner of a side panel, measure 5 inches to the right along the factory edge and make a first mark. Then, at this first mark, use the combination square to draw a line perpendicular to the factory edge across the panel.

16) Now, again from the left corner, measure and make a second mark 1-1/4 inches up the left side.

17) Now, from the factory edge, measure and make a third mark 1-1/4 inches up the perpendicular line made in step 15. Then, use a straight edge to draw a 5 inch line from the second to third mark.

18) Place the 45 degree surface of combination square's head against the factory edge and extend and position the rule so you can draw a 45 degree line from the third mark to the right and up to the top edge. Using previous cutting methods cut along the 5 inch and 45 degree lines making a curved transition at their junction. See Figure 3.

19) Repeat steps 15 through 18 to cut a handle in the second side panel. Note that both side panels now have a 2-1/4 inch wide end and a 1-1/4 inch narrow end.

In the next three steps, mark both side

panels to show where the elements will pass through.

20) Refer to Table 3. Use the combination square to measure and mark on the top edge (non-factory edge) 1/4 inch in from the wide end. Now, use the tape measure to mark the remaining element positions along the top edge.

21) Now, at each marked element position, use the combination square to draw a line perpendicular to the factory edge (bottom edge) and across the side panel. Then, re-adjust the combination square to measure and place a cross-mark on each line at a point 1-3/8 inches up from the factory edge. At the driven element line only, make a second cross-mark 1-7/8 inches up from the factory edge. See Figure 3.

22) Repeat Steps 20 and 21 to mark the second side panel the same way as the first, EXCEPT on the opposite side than the first (i.e., the second side panel's markings are a mirror image of the first side panel's markings).

In the next step, make holes for the elements in one side panel only.

23) Place the first side panel on a pine board and push the shish-kebab skewer partway through at an element location until it just barely pokes through. Wiggle the skewer, if it helps. Then turn the panel over and poke the skewer back through all the way to complete the hole. Do this for all seven element holes.

In the next three steps, laminate the side panels to the inner core, wrap the handle and finish making the element holes.

24) Position the first side panel so the element position markings are facing one side of the inner core. Now, using previous laminating methods laminate the first side panel to the inner core.

25) Using previous laminating methods laminate the second side panel to the other side of the inner core, after lining-up the wide end(s) of both side panels.

Then, wrap the handle with one layer of clear packing tape.

26) Re-push the skewer through the reflector element hole until it just touches the associated cross-mark on the second side panel. Use the combination square to verify the skewer is perpendicular with respect to the boom. If not, adjust the actual new puncture point so the skewer is perpendicular to the boom, and using the method in Step 23, make the hole. Repeat this until all seven element holes in the second side panel are made.

In the next four steps, fabricate the antenna driven element out of #8 AWG aluminum wire.

27) Straighten out a 24 inch length (hereafter called a wire) from the #8 AWG aluminum ground wire. Use the combination square to measure and mark (with the permanent marker) 8 inches in from a wire-end. At the mark, bend the wire around a 3/8 inch diameter drill bit (if nothing else, remove the blade and use the X-Acto knife handle) until the short segment is parallel with the long segment and the two segments are spaced 1/2 inch apart. If the aluminum wire dirties your hands, wipe it down with paper towels dampened with a spray cleaner such as Windex.

28) Use the combination square to measure 13 inches along the long segment starting from the bend. Mark and final cut the wire here as follows: With the diagonal cutters, cut the wire halfway, rotate the wire 90 degrees, and cut halfway again. Bend the wire back and forth until it snaps in two. Use the mill file to bevel and smooth over the remaining rough and sharp edges. Use this method to get a smooth, rounded wire-end when a final cut is called for.

29) Find the halfway point, or center, of the long segment. This should be at $13 \text{ inches} / 2 = 6-1/2 \text{ inches}$ from either end.



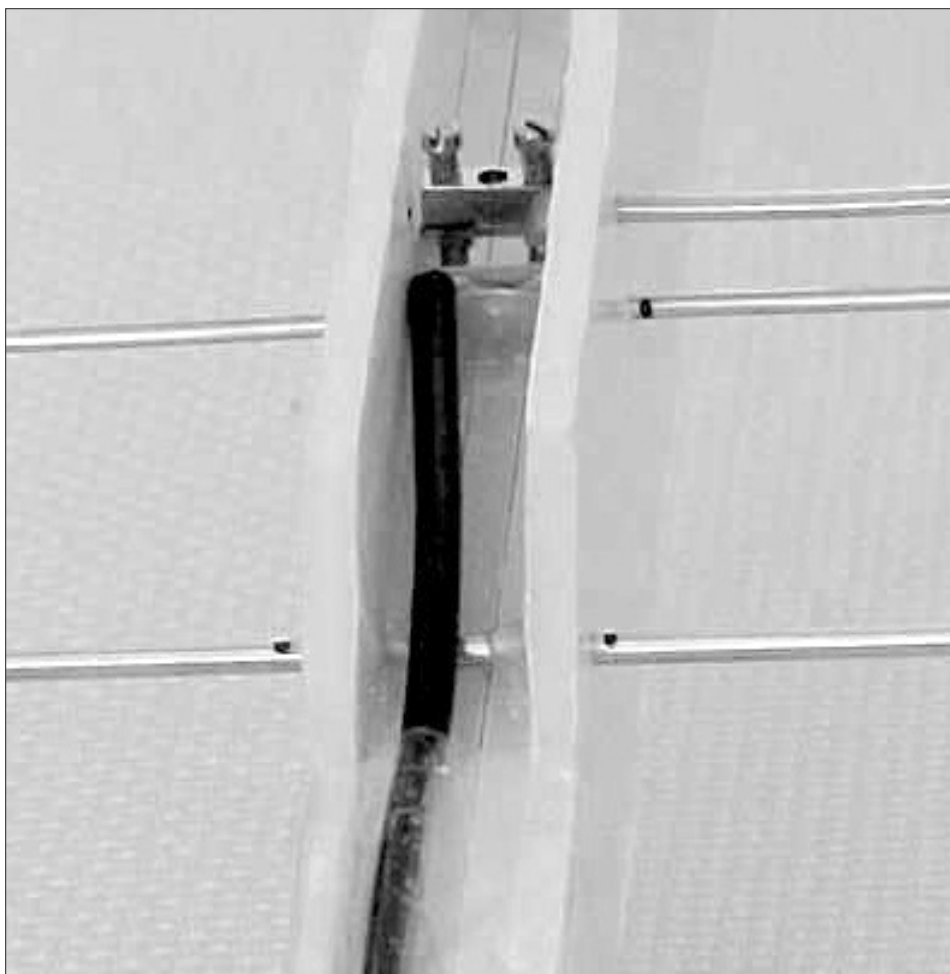


Figure 4: Driven element detail.

Now, get ready to make two marks, the first $\frac{5}{8}$ inches to the left, and the second $\frac{5}{8}$ inches to the right, of the center. Do this by adjusting the combination square to $6\frac{1}{2} - \frac{5}{8} = 5\frac{7}{8}$ inches. Now, measure and mark $5\frac{7}{8}$ inches in from the bend and also $5\frac{7}{8}$ inches from the cut end. These marks will help you to center the element later.

- 30) In a way similar to Step 28, final cut the short wire segment to $7\frac{1}{16}$ inches measured from the bend.

In the next four steps, prepare the coaxial cable which will be the antenna's feed line.

- 31) Take the RG-58 coaxial cable assembly (hereafter called the cable) and use the diagonal cutters to cut off one of the BNC connectors. Measure and mark the cable jacket 3 inches down from the cut end.
- 32) Be sure the X-Acto knife has a fresh, sharp blade. Place the cable on a pine board and gently roll it back and forth under the X-Acto knife to cut halfway through the jacket, all the way around,

at the mark. Gently bend the jacket back to examine, and promote, the depth of the cut. Use a similar technique to slit the jacket from here up to the cable end, cutting all the way through the jacket only as you near the end. Now, pull the rest of the jacket apart and remove it.

- 33) Unbraid the shield wires until stopped by the new jacket end point. Trim off half the shield wires and twist the remaining wires clockwise to form a 3 inch long 18 AWG size bare stranded wire shield conductor.
- 34) Cut the center conductor to a $1\frac{3}{4}$ inch length. In a way similar to Step 32 cut the center conductor insulation halfway, all the way around, $\frac{1}{2}$ inch down from the wire-end. Twist the insulation clockwise to complete the cut, then twist and pull it off. Similarly, remove another $\frac{1}{2}$ inch, and then another. Use the 4" long nose pliers, as needed, to twist and pull-off the center insulation. In the end, the visible center conductor should have $\frac{1}{4}$ inch of insulation remaining, and from there to wire-end,

$1\frac{1}{2}$ inches of bare, clockwise-twisted wire.

In the next three steps, install the driven element and attach the coaxial cable using the "N2SPI No-Solder Connection Method".

- 35) Use the flat $\frac{1}{8}$ " blade screwdriver to back-off the screws in both connectors, if necessary, until no screws are entering the wire chamber. Then, slide one connector over the coaxial cable shield conductor. Locate the pair of holes in the side panel for the driven element's long segment. Place the connector installed on the shield wire between these holes with its screws facing forward and tilted up. The coax shield should come out of the side of the connector opposite the first hole which the driven element will pass through. Then, push the long element segment through the hole in the side panel and into the connector. As you're doing this, use the 4" long nose pliers, as needed, to position and hold things in place. See Figure 4.

- 36) Slide the other connector over the coax center conductor. Locate the pair of holes in the side panel to be used by the driven element's short segment. Place the connector installed on the center conductor between these holes with its screws facing up. The center conductor should be on the same side as the shield. Push the short segment through the side panel into the connector, while moving more of the long segment. Keep pushing the short segment through the connector until a little bit of it passes into the other side panel but doesn't extend beyond it. Having the short segment, as well as the long, held by both side panels considerably strengthens the attachment of the driven element to the boom. See Figure 4.

- 37) When the driven element is centered, and its hairpin is straight and not twisted, and the pigtails between the coax and connector are $\frac{3}{8}$ inch in length, tighten all screws. Apply a couple of dabs of hot melt glue to hold the driven element in place. Then trim away the excess wire with the X-Acto knife.

In the last five assembly steps, cut the remaining antenna elements out of the #8 AWG aluminum wire and install them.

- 38) Final cut five, 14 inch straightened lengths out of the #8 AWG aluminum wire.





Figure 5: The N2SPI Cheap and Easy Satellite Downlink Antenna in action.

- 39) Refer to Table 3. From the final cut end of a 14 inch wire, use the combination square to carefully measure and mark the specified length and then final cut each element, i.e., both wire ends receive the final cut treatment.
- 40) Similar to Step 29, find each element center. Make two marks $\pm 5/8$ inch from the center of each element.
- 41) Locate the pair of holes for each remaining antenna element in the side panels. Push each element through their pair of holes and then center them. Rotate the element wire while you push, if it helps.
- 42) Apply a dab of hot melt glue to the middle of each element to hold it in place. When done, use some clear packing tape to secure the coaxial cable to the top of the handle part of the boom. See Figure 4.

And finally, test your new satellite downlink antenna.

- 43) Test your new antenna by using it to actually receive a satellite's signal, say AMSAT's AO-51 downlink. See Figure 5. To do this:
 - a) Determine when AO-51 is in line-of-sight range of your location. For example, go to www.heavens-above.com, select your location under Anonymous Users, and navigate to radio amateur satellites. Then look for start and end times for AO-Echo (AO-51) passes. After a start time, AO-51 will rise in the sky until it reaches a maximum altitude and then start to fall. Note that Heavens Above gives you the "time", "Alt." and "Az." for the maximum altitude. Click on these terms for an explanation.
 - b) To use the time based pass information successfully, you'll need to be able

to tell time accurately. Verify your wristwatch, or other timepiece, against the official United States time, which you'll find at <http://tf.nist.gov>.

- c) To determine if AO-51 is in a suitable mode, go to www.amsat.org, click on Amateur Satellite Status and then click on the AO-51 Schedule to make sure the U downlink (435.300 MHz) is active.
- d) To receive AO-51, connect your new antenna to a UHF narrow band FM receiver, preferably with tuning steps of 5 KHz or less, and tune it to 435.300 MHz. This receiver can be most any Amateur Radio 440 MHz HT, 440 MHz mobile transceiver, wide band receiver or police scanner. Personally, I use an Alinco DJ-S40T pocket sized UHF HT for my FM downlink receiver (\$90 at www.aesham.com). Also, a low noise 440 MHz receive preamp can improve reception considerably. I use a Hamtronics LNK-450 preamp (\$60 at www.hamtronics.com). I rig up two 9 volt battery clips in series (Radio Shack #274-324) to power the LNK-450 from two 9 volt batteries. Also, full cup headphones will help you hear AO-51's signal more clearly and will be a must when you transmit on the uplink. I use Vanco HF-24RS scanner headphones (\$20 at www.aesham.com).
- e) Initially, take your antenna and receiver

outside to a location where you can aim your antenna by hand toward AO-51 when it will be in unobstructed sky at, or near, a maximum altitude of 30 degrees or more. Wave the antenna around in general direction of the satellite and rotate it around the boom axis until you hear the strongest signal.

- f) And finally, you will hear AO-51 at exactly 435.300 MHz when it is at, or near, maximum altitude. But at other times in the pass, because of Doppler frequency shift, you'll have to tune somewhere between 435.290 to 435.310 MHz to find the clearest reception.
- g) Other satellites to listen for are AO-27 and SO-50 (a.k.a. SAUDISAT 1C), which both downlink on 436.795 MHz. Check www.amsat.org for their status and characteristics. Also, if you prefer, you can use the online satellite pass predictions at www.amsat.org.

In Conclusion ...

If you need assistance building or using this satellite downlink antenna or have other questions or comments, contact me at: n2spi@amsat.org. Please put the phrase "Satellite Downlink Antenna, v2.0" somewhere on the email subject line.

Table 1: List of Materials

Quantity Used	Material Description *	Example Source	Item No. **
1	"Elmer's" 20 inch x 30 inch Foam Board	Staples	245555
240"	"Scotch 665" Permanent Double Sided Tape	Staples	130500
36"	Clear Wide Cellophane Packing Tape	Staples	490802
94"	#8 AWG Aluminum Ground Wire	Radio Shack	15-035
1	Euro-style 12 mm Terminal Strip	Radio Shack	274-677
1	RG-58 Coax Jumper Cable, BNC to BNC, 6 ft.	Radio Shack	278-964

* Name in quotes is the brand of product I used. Equivalents should be OK.

** Some Example Item Numbers come packaged in higher quantities than Qty Used.





Table 2: List of Tools

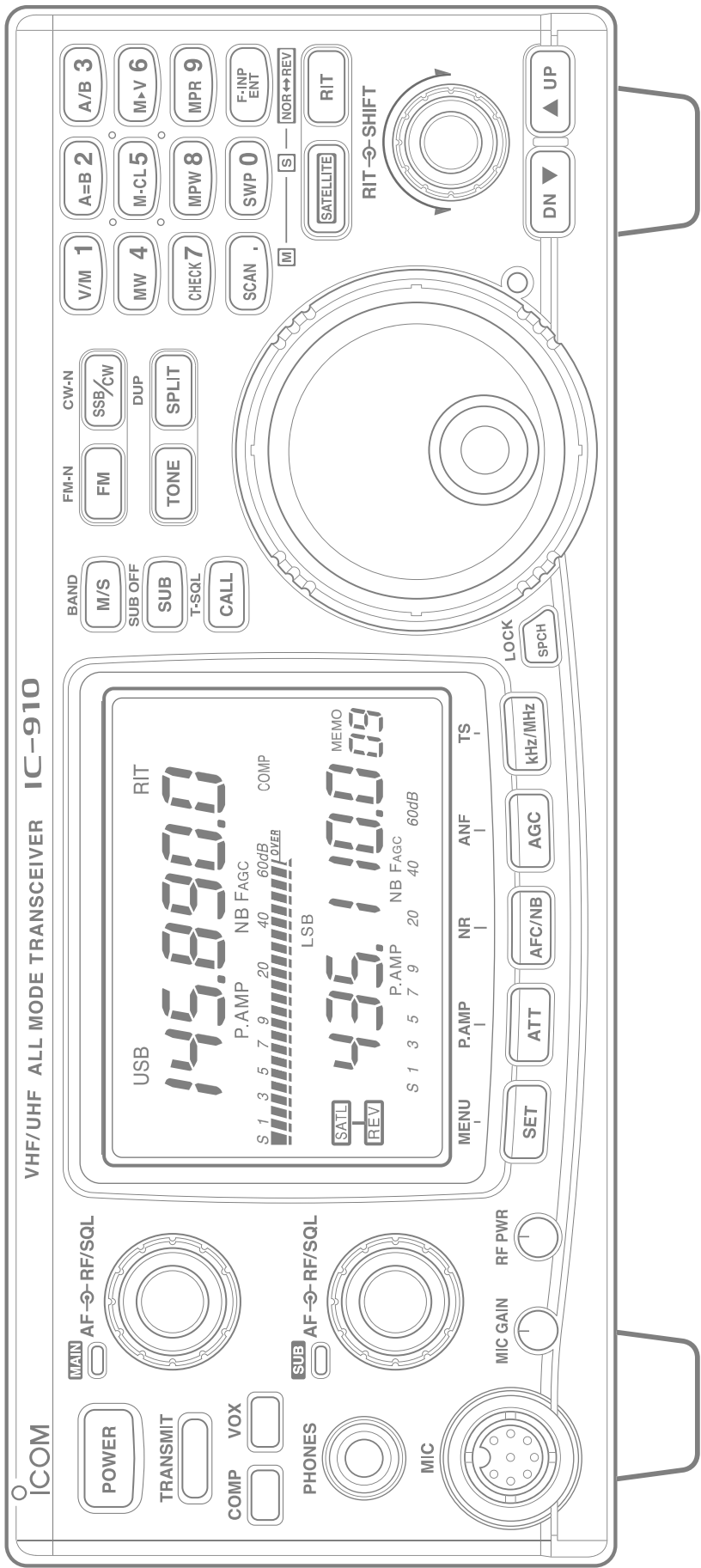
Tool Description	Source	Item Number
16" Combination Square	Sears	00939681000
Small Tape Measure	Sears	00939697000
Flat 1/8" Blade Screwdriver	Sears	00941421000
6" Diagonal Cutters	Sears	00945075000
4" Long Nose Pliers	Sears	00945698000
Mill File	Sears	00931300000
"Sharpie" Ultra Fine Point Permanent Marker	Staples	498386
"X-Acto" Knife with #11 Blade	Staples	506998
"X-Acto" #11 Blade Refills	Staples	428300
Hot Melt Glue Gun with Glue Stick	Staples	508701
36" Straight Edge (Metal Yardstick)	Wal-Mart	
1/16" Square Shish-Kebab Skewer	Supermarket	
36" long Pine Boards, Qty = 2 (see Steps 7 and 8)	Lumberyard	
Sharpened Pencil		

Table 3: Element positions and element lengths for the 440 MHz antenna.

Antenna Element Name	Element Position from the Wide End (in inches)	Element Length * (in inches)
Director 4 (D4)	1/4	11
Director 3 (D3)	6-3/4	12
Director 2 (D2)	13	12
Director 1 (D1)	18-3/4	12-3/8
Driven Element (DE)	21-3/4	13
Reflector (REF)	24-1/4	13-3/8

* Try to cut the element length to within +/- 1/32 of an inch.





910H. Actual Size (Space is infinite. Your shack is not).

Don't let the size fool you, there's never been a rig bred more specifically for satellite ops. A big-screen, dual-frequency readout sets the scene while smooth Doppler compensation lets you follow the action. With .11µV sensitivity and true dual tracking VFO's. Add optional down converters, pre-amps and DSP for an almost complete off-the-shelf system. But the sky is not the limit with the 910H. For terrestrial operation, it more than delivers everything you need. Whether you're working FM repeaters, or tracking the newest satellite, the 910H puts you in command. See your authorized Icom dealer.

- 100W Variable Output • All Mode • Simultaneously Works Two Bands at Once • 9600 bps High Speed PACKET Port • .11 µV Sensitivity • Main & Sub Band Functions for IF Shift, Sweep, NB, RF Attenuator • Large LCD Display • Four Versatile Scanning Functions • CTCSS Encode/Decode/Tone Scan - Even in Satellite Mode! • Built-in Keyer • PC Controllable • Memory Pad • Normal/Reverse Satellite Tracking • Size (approx): 9.5" W x 3.687" H x 9.437" D • Weight: 9.5 lbs.

AG-2400

Downlink Receive Converter

Converts a 2400MHz RF signal to a 144MHz IF signal, allowing US mode operation. Use with optional UX-910, for LS mode operation.

AG-25

144MHz

AG-35

430MHz

External all-weather, mast mounting preamplifiers. Compensates for cable loss.

UX-910

1200MHz Band Unit

Turns the IC-910H into an all mode, tri-band transceiver. Also makes crossband and full duplex operation possible.

UT-106

DSP Unit

AF-DSP functions, including noise reduction and automatic notch filter. Use two, one for main band & one for sub-band.

Accessories